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NEW ZEALAND INSTITUTE.

NOTICE TO MEMBERS.

THE publications of the New Zealand Institute consist of—

1. **Transactions,** a yearly volume of scientific papers read before the local Institutes. This volume is of royal-octavo size, and is issued about the 1st June of each year.

2. **Proceedings,** containing reports of the meetings of the Board of Governors of the New Zealand Institute and of the local Institutes, abstracts of papers read before them and of papers dealing with New Zealand scientific matters and published elsewhere, list of members, &c. The Proceedings are of the same size as the Transactions, and are bound up with the yearly volume of Transactions supplied to members.

   The Transactions and Proceedings are posted direct to members of the Institute from the Printing Office. For this purpose the Secretaries of the local Institutes must, before the 1st January in each year, forward a list of members, with addresses, to the Secretary of the New Zealand Institute, and see that it is corrected from time to time when necessary. It is the duty of members to inform the Secretary of their local Institute of any change in their address.

3. **Bulletins.** Under the title of "Bulletins" the Board of Governors hopes to be able to issue from time to time important papers which for any reason it may not be possible to include in the yearly volume of the Transactions. The bulletins are of the same size and style as the Transactions, but appear at irregular intervals, and each bulletin is complete in itself and separately paged. The bulletins are not issued free to members, but may be obtained by them at a reduction on the published price.

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1. All papers must be typewritten, unless special permission to send in written papers has been granted by the Editor for the time being.

2. The author should read over the typewritten copy, and, if necessary, correct it, before sending it to the Secretary of the society before which it was read.

3. A badly arranged or carelessly composed paper must be sent back to the author for amendment by the Council of the society before which it was read. It is not the duty of an editor to amend either bad arrangement or defective composition.

4. In regard to underlining of words, it is advisable, as a rule, to underline only specific, generic, or family names, or foreign words.

5. In regard to specific names, the International Rules of Zoological Nomenclature in relation to zoological names, and the International Rules for Botanical Nomenclature, must be adhered to.

6. Titles of papers should give a clear indication of the scope of the paper, and such indefinite titles as, *e.g.*, "Additions to the New Zealand Fauna" should be avoided.

7. Papers should be as concise as possible, all unessential details being omitted.

8. Photographs intended for reproduction should be the best procurable prints, unmounted and sent flat.

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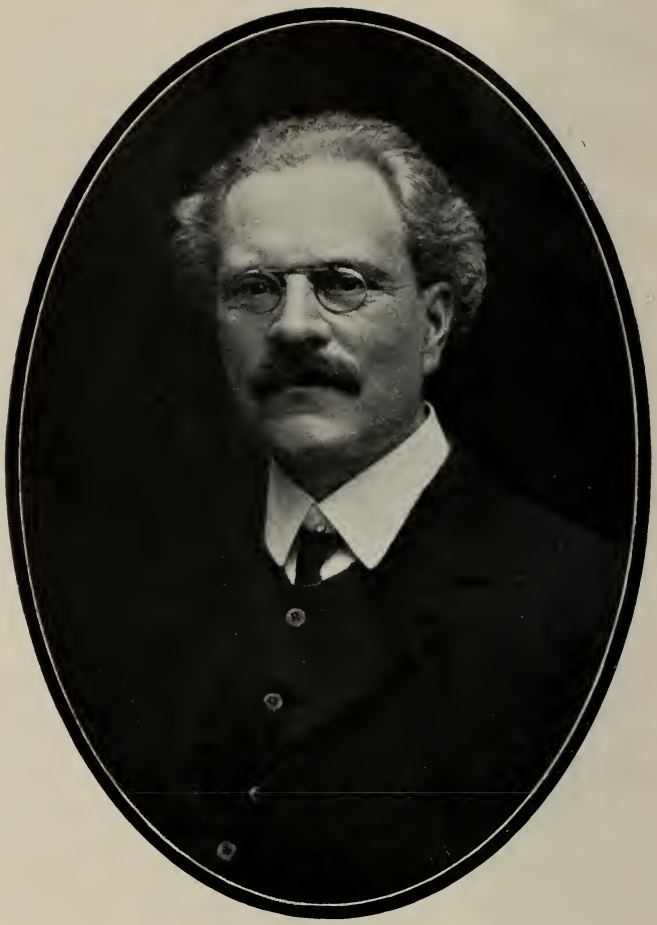
13. In ordinary cases twenty-five copies of each paper are supplied gratis to the author, and in cases approved of by the Publication Committee fifty copies may be supplied without charge. Additional copies may be obtained at cost-price.

14. References to the Transactions should be made by the number of the volume and, if required, by the *year of publication*, not the year in which the paper referred to was read—*e.g.*, "Trans. N.Z. Inst., vol. 44, p. 161, 1912."

By order of the Board of Governors.



AUGUSTUS HAMILTON.

[*Frontispiece.*

Royal Society of New Zealand

TRANSACTIONS

AND

PROCEEDINGS

of the Royal Society of New Zealand,

OF THE

NEW ZEALAND INSTITUTE

FOR THE YEAR 1913

VOL. XLVI

(New Issue)

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OBITUARY.

AUGUSTUS HAMILTON.

Augustus Hamilton was born at Poole, Dorset, in the year 1854. He was educated at Dorset County School and at the Epsom Medical College.

In 1876 he came to New Zealand, and taught successively at Thorndon, Okarito, and Petane. While at the last-named school he began his long connection with the New Zealand Institute by becoming Secretary to the Hawke's Bay Philosophical Society. The museum of this Society is a memorial of his work. In 1890 Hamilton was appointed Registrar of the University of Otago. The period of his Registrarship was by far the most productive in his life, as is indicated by the great list of papers on botany, zoology, and ethnology in the "Transactions of the New Zealand Institute" for those years. In his later years at Otago he was engaged on his great work "Maori Art," which overshadows all his other contributions to science. In 1903 he was appointed Director of the Colonial Museum, and his energies thereafter were employed in increasing the ethnological, historical, and entomological collections of that institution. Latterly he was troubled by ill health, and his death, which occurred at the Bay of Islands on the 12th October, 1913, came as the result of a paralytic stroke.

The range of Hamilton's knowledge was remarkable. At one time or another he wrote papers of value on almost every branch of natural science. His achievement in the field of ethnology will be discussed later. Next in importance comes his long series of hand-lists or bibliographies. These are all of great practical value to students, and deal with such varied subjects as New Zealand botany, ferns, fossil *Bryozoa*, *Dinornithidae*, fishes and fishing, geology, and the Maori race.

He was, above all things, a collector and systematizer, whether as a zoologist among the bones at Castle Rocks, or as a botanist in the wilds of southern Westland and on Macquarie Island, or as the gatherer of his unrivalled collection of New Zealand stamps, or, most of all, as a collector of objects throwing light on the life, industry, and art of the ancient Maori.

Hamilton was the sole worker among New Zealand ethnologists in a department that among the ethnologists of Europe and America is perhaps more strongly manned than any other. Avoiding the investigations already afoot as to sociology, anthropometry, linguistics, and the history and mythology of the Maoris, he turned his energies entirely to the study of industrial processes and to the collection and description of objects of every kind that threw light upon Maori art. It is remarkable that though each of those other fields has had many workers, and in each some excellent work has been done, there has as yet been only one systematic worker in the field of Maori technology and art—a department which, from the tangible nature of its subject-matter, its aesthetic appeal, and the information it may yield on race-history and race-affinities, is the most attractive of them all. The history of Hamilton's ethnological work is the history of this department of the science in New Zealand.

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The foundations of his Maori collection were laid in the early years of his residence in New Zealand, when he collected with characteristic energy and thoroughness in the region centred at Hawke's Bay. Here he secured most of the wood-carving, the flax fabrics, and the articles connected with fishing—in all, the largest part of his collection. To this period belong his first field expeditions among the ancient village sites of the East Coast and about Porirua. Though he had visited Okarito, the stay had not, I believe, contributed anything to his ethnological material. The most interesting period, though the articles collected bulked less largely than those of Hawke's Bay, came with his removal to Dunedin on his appointment to the Registrarship of Otago University. The beaches along the east coast of Otago are the classic collecting-ground of New Zealand, and here the most interesting part of his collection was brought together. In company with Mr. (now Mr. Justice) Chapman he excavated the camping-ground of the moa-hunters at Shag Point. The tedious work of digging and sifting sand was carefully carried out, and an observation of some importance historically was made—namely, that greenstone was known to and worked by the men who hunted the moa.

When, on the retirement of Sir James Hector, Augustus Hamilton was appointed Director of what is now the Dominion Museum the Government acquired his collection, and he devoted his powers to the augmentation of the national collection. His work at the Dominion Museum was in all but one respect a complete success. The confidence he inspired in other collectors and ethnologists was shown by the splendid gifts to the Museum of the Buller collection, the Turnbull collection, the objects brought to England by Captain Cook and presented by Lord St. Oswald, and by many other gifts. The one respect in which he fell short of complete success was his failure to persuade successive Ministers of Finance to house adequately the material he had brought together.

But whatever fame the future may give him will come to him more as a writer than as a collector. The whole of his written contributions to the science of ethnology are descriptive: accounts of Maori artifacts and designs or of the results of archaeological work, and the conclusions that might safely be deduced from them. The two outstanding features of these contributions are, first, complete detachment from the influence of theories as to the origin or relationships of artifacts and designs, and, second, thoroughness and accuracy. In "Maori Art" and in the Bulletins of the Dominion Museum he brought together and systematized a great mass of facts which must form the starting-point of all future research in these fields. The whole theory of the subject has yet to be written, but the ground has been cleared and the foundation laid by the work of Augustus Hamilton.

In a stimulating chapter on Maori art, Max Hertz affirms it the chief defect in Hamilton's work that he advanced no theory as to its origin or affinities. But in truth this avoidance of all theory was one of his greatest merits. It is not rash to say that the bulk of the writings on Maori ethnology have been warped by the influence of preconceived theory. It needed strength of purpose to resist an influence which thus flowed in from every quarter. Hamilton knew that facts enough had not yet been recorded to form the basis of scientific theory, and he resolutely set himself to the accumulation of facts. It is from such a groundwork that students of the future will be able to venture with some certainty into the region of hypothesis.

When he died, Augustus Hamilton, though not an old man, was the last of the old generation of New Zealand naturalists. He had, in some degree, made a name as a botanist, as a geologist, and as a zoologist; but his fame, if the future holds fame for him, will come to him as one who made a national collection as no one else could have done, and as one who laid the foundations on which will rest the science of Maori technology and Maori art.

In closing this brief review, a student of that subject which Augustus Hamilton made his own may pay a tribute to the unfailing kindliness which put at the service of the youngest inquirer his immense stores of information, and to his exhaustless patience in rendering accessible the treasures placed with such inadequate equipment under his guardianship and control.

H. D. Skinner.

JAMES STEWART, M.Inst.C.E.

James Stewart was born in Perthshire, Scotland, in 1832, and was educated at the Perth Academy. After practising for some years as a civil engineer in Perth he came to Auckland in 1859 and entered upon the practice of his profession. Here he was successful in obtaining the award offered for a design for the Auckland waterworks, and in 1862 he was appointed Engineer to the Auckland City Board of Works. After rendering useful service in the Waikato War, he held various public offices and prepared the designs for many important works, and in 1874 the whole of the railway-works in Auckland were placed under his charge as District Engineer. In 1881, owing to the need for retrenchment, he was retired from the public service and recommenced private practice, and for many years was looked upon as the leader of his profession in Auckland, and few important engineering-works were carried out without his opinion being first obtained.

During this strenuous career he still found time to devote his attention to subjects outside his profession, and from the first took an active interest in the proceedings of the Auckland Institute. Mr. Stewart was one of the original members of the Institute, having joined it on its formation in 1868. With two short intervals, he has been a member of the Council since 1871. He was President in 1890, and again in 1901. Since 1903 he has been one of the representatives of the Institute on the Board of Governors. In 1906 he was appointed a Trustee of the Institute, a position which he occupied at the time of his death. His sound practical knowledge and good common-sense were of great service to the Institute, and his opinions were always received with respect. In the Index to the first forty volumes of the Transactions of the New Zealand Institute Mr. Stewart's name appears as the author of fifteen communications printed in the Transactions.

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TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1913.

Art. I.—*Contributions to a Fuller Knowledge of the Flora of New Zealand: No. 5.*

By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 3rd December, 1913.*]

I. Ranunculaceae.

Clematis indivisa Willd.

In the Students' Flora Mr. T. Kirk constituted three varieties of this plant, describing them as follows: "Var. *b*, *lobulata*, leaflets toothed or lobulate, flowers smaller; var. *c*, *decomposita*, leaflets 2-ternate; var. *d*, *linearis*, leaflets narrow-linear, 3–7 in. long, $\frac{1}{4}$–$\frac{1}{2}$ in. broad, entire or with two lateral lobes at the base." For many years I have been convinced that these three forms are nothing more than juvenile states of *C. indivisa*, and I am now able to offer satisfactory proof of this. In August, 1912, Mr. H. B. Morton gave me a number of young seedlings of *C. indivisa*, varying in height from 4 in. to 8 in. They all had narrow-linear leaves 3 in. to 4 in. long, closely resembling the leaves of very young plants of *Parsonsia heterophylla*. They were planted in richly manured soil at the foot of a tall trellis, and made very rapid growth. The simple linear leaves soon gave place to trifoliolate leaves with linear leaflets, which in their turn were followed by others in which the leaflets were broader and much cut and lobed, in a few instances being twice ternate. By August, 1913, or within twelve months, some of the stems had reached the height of 12 ft., and produced flowers abundantly. In the meantime the upper leaves had assumed the ordinary shape of the adult—that is, with ovate-oblong entire or slightly toothed leaflets. At the present time (November, 1913) almost all traces of the early leaves have been lost. At the same time, as several observers, including myself, have seen flowering specimens with lobulate leaflets, it may be taken for granted that the juvenile foliage sometimes persists for a few years.

Ranunculus Godleyanus Hook. f.

Fitzgerald's Pass, Mount Cook district; *P. Graham!* Specimens rather smaller than some gathered in a very similar situation on Whitcombe's Pass by Sir Julius von Haast and Mr. J. D. Enys, but not otherwise different.

III. Cruciferae.

Lepidium tenuicaule T. Kirk.

I am indebted to *Mr. B. C. Aston* for specimens of this collected on Kapiti Island. It is not mentioned in Dr. Cockayne's list of the plants of the island.

IV. Violaceae.

Hymenanthera novae-zealandiae Hemsl.

Mayor Island and Karewa Island, Bay of Plenty; *Dr. Thilenius!* These localities, which are the most southern known, were accidentally omitted in the Manual.

V. Pittosporaceae.

Pittosporum virgatum T. Kirk.

Taumata-mahoe Range, to the east of Ahipara, Mongonui County; *H. Carse* and *H. B. Matthews!*

VIII. Elatinaceae.

Elatine americana Arn. var. australiensis Benth.

Muddy places near Lake Tongonge, Kaitaia; *H. B. Matthews!*

XI. Tiliaceae.

Aristotelia racemosa Hook. f.

Mr. F. R. Field sends me leaves of this, obtained near the Hawai River, Opotiki, which are quite 10 in. long, including the petiole.

Aristotelia fruticosa Hook. f.

Kaikuri, near the Waitomo Caves; *E. Phillips Turner!* The most northerly station yet noted on the west coast of the North Island, but on the east coast it advances as far north as the Cape Colville Peninsula.

XIII. Geraniaceae.

A complete revision of this family has been prepared by the well-known botanist *R. Knuth* for the "Pflanzenreich," of which it forms Heft 53. The nomenclature adopted for the New Zealand species is as under:—

1. *Geranium dissectum* Linn. var. *glabratum* Hook. f. Knuth does not actually quote any New Zealand localities for this, but as he accepts the variety as defined by Hooker I take it that the New Zealand plant is included.

2. *Geranium molle* Linn.

3. *Geranium sessiliflorum* Cav. var. *glabrum* Knuth. This variety includes the New Zealand and Tasmanian forms, the distinguishing characters being given as "Pedunculi petiolique retro-adpressi pilosi. Folia glabrescentia." The type of the species, which is confined to South America, has the foliage densely clothed with adpressed hairs.

4. *Geranium pilosum* Forst. f. Includes Hooker's two varieties *pilosum* and *patulum* of *G. dissectum.* For the last-mentioned Knuth proposes the new name of "*grandiflorum.*"

5. *Geranium microphyllum* Hook. f.

6. *Geranium Traversii* Hook. f.

7. *Pelargonium inodorum* Willd. This, which answers to the *P. australe* var. *clandestinum* of Hooker and other authors, is considered by Knuth to be sufficiently distinct to be retained as a separate species. He also quotes the typical *P. australe* as a New Zealand plant; but as he gives the locality as "Port Phillip," and the collector's name as Luehmann, it is tolerably clear that a mistake has been made.

Knuth also gives New Zealand for one of the habitats of the Australian *Erodium cygnorum;* but, so far as I am aware, it has never been seen in New Zealand, either as an indigenous or naturalized plant.

XVIII. RHAMNACEAE.

Pomaderris elliptica Lab.

Northern slope of Pirongia Mountain, Waipa Valley; *B. C. Aston!* The most southern locality yet recorded on the western side of the North Island.

XXIII. ROSACEAE.

Rubus cissoides A. Cunn. var. **pauperatus** T. Kirk.

Not uncommon on raised beaches at Cape Turakirae, near the entrance to Wellington Harbour; *B. C. Aston* and *T. F. C.*

XXVI. DROSERACEAE.

Drosera pygmaea D.C.

Waimarino Plains, western base of Ruapehu; altitude, 2,500 ft.; *E. Phillips Turner!* Not previously recorded in New Zealand from any locality between the extreme north of the North Island and the extreme south of the South Island; but it is probably not uncommon in moist peaty situations, and is overlooked on account of its small size.

XXVIII. MYRTACEAE.

Metrosideros Parkinsoni Buch.

State Coal Reserve (Liverpool Mine), near Greymouth; *P. G. Morgan!* This is a marked extension of the southern range of this fine plant.

XXXI. CUCURBITACEAE.

Sicyos angulatus Linn.

This is fast becoming scarce on the mainland, although still plentiful on many of the outlying islands. Of new records, I may mention Goat Rock, off Tiritiri Island (*A. Hansen!*); and the D'Urville Islands, off the eastern entrance to Auckland Harbour (*T. F. C.*).

XXXIII. UMBELLIFERAE.

Angelica geniculata Hook. f.

On rocks at Little Akaroa, Banks Peninsula; *Rev. F. R. Spencer!*

XXXVII. Compositae.

Olearia nitida Hook. f. var. **angustifolia** Cheesem.

Not uncommon in the vicinity of the Ngakawau River, to the north of Westport; *P. G. Morgan!* I have also received from Mr. Morgan a form almost intermediate between var. *angustifolia* and the type, collected at Seddonville, near the Mokihinui River.

Olearia virgata Hook. f.

Attains a height of 25 ft. in the Marikopa Valley, south of Kawhia; *E. Phillips Turner!* This is the most northerly locality yet recorded on the west coast of the North Island, but on the eastern side it advances as far as the Ohinemuri Gorge.

Olearia Solandri Hook. f.

Motuara Island, Queen Charlotte Sound; *J. H. Macmahon!*

Celmisia rupestris Cheesem.

Mount Aorere, north-west Nelson; *F. R. Gibbs!* A slight northwards extension of the range of this local species, which I discovered on Mount Peel, Nelson, in 1881.

Gnaphalium subrigidum Col.

Tinui, inland from Castle Point; *J. S. Tennant!* Cape Turnagain and the Puketoi Range; *B. C. Aston!* Makuri Gorge, west of Puketoi; *E. Phillips Turner!* I do not know of any previously published records for the eastern side of the Wellington Provincial District, but probably it will be found to be not uncommon in open rocky places.

Senecio glaucophyllus Cheesem.

I have to thank *Mr. F. R. Gibbs* for a fresh supply of specimens of this interesting species, obtained in the locality where it was originally discovered by myself in 1886, among limestone rocks in a ravine on the northern face of Mount Arthur, Nelson. It has not yet been seen elsewhere.

XLIII. Epacridaceae.

Archeria racemosa Hook. f.

Plentiful on Whanakao Mountain, near Hikurangi, East Cape district; also at the head of the Keru Stream, which enters the sea near Te Kaha, descending as low as 250 ft. above sea-level; *Mr. Sherwood.*

XLV. Myrsinaceae.

Myrsine chathamica F. Muell.

On one of the "mutton-bird" islands between Stewart Island and the Bluff; *H. Guthrie-Smith!* Dr. Cockayne quotes only the two localities of Wilson Bay and Old Neck, so far as Stewart Island is concerned.

Myrsine nummularia Hook. f.

Summit of Mount Hikurangi, East Cape district; altitude, 5,000 ft.; *G. W. Williams!* The most northern locality yet observed.

L. GENTIANACEAE.

Sebaea ovata R. Br.

Boggy places on raised beaches near Cape Turakirae, Cook Strait; *B. C. Aston* and *T. F. C.* The first record for this local plant within the Wellington Provincial District.

LIV. SCROPHULARIACEAE.

Gratiola nana Benth.

Sandy beaches on Lake Whangape, Middle Waikato; *T. F. C.*

Veronica Townsoni Cheesem.

Mr. A. Allison, of Wanganui, sends me cultivated specimens of this in which the lower racemes are trifid.

LVIII. VERBENACEAE.

Vitex lucens T. Kirk.

A variety with cream-coloured flowers is occasionally seen.

LXXII. LORANTHACEAE.

Korthalsella salicornioides Van Tiegh.

Parasitic on *Leptospermum* on hills at Kuaotunu, to the south of Mercury Bay; *J. W. Shannon!*

LXXIV. BALANOPHORACEAE.

Dactylanthus Taylori Hook. f.

I am indebted to *Mr. J. R. Murphy* for specimens collected on the Mount Egmont Ranges.

LXXV. EUPHORBIACEAE.

Poranthera alpina Cheesem.

Dr. Gruning, in his revision of the subfamilies *Porantheroideae* and *Ricinocarpoideae*, published in "Das Pflanzenreich" (Heft 58), constitutes a separate section (*Oreoporanthera*) of the genus for the reception of this species, which is distinguished from all its allies by the uniformly dioecious and apetalous flowers, which are solitary in the axils of the upper leaves, and by the more or less coriaceous stipules.

LXXVI. URTICACEAE.

Paratrophis Banksii Cheesem.

Valley of the Orongorongo River, discharging near Cape Turakirae, not far from the entrance to Wellington Harbour; *B. C. Aston* and *T. F. C.* As Solander's *Trophis opaca* seems to have been founded solely on this species, and not on *P. heterophylla*, it would be more in accordance with the rules of botanical nomenclature to use his specific name.

LXXIX. ORCHIDACEAE.

Bulbophyllum tuberculatum Col.

I am indebted to *Mr. H. B. Matthews*, of Kaitaia, for an ample supply of living specimens in full flower of this beautiful little plant. He informs

me that it is usually found on the upper portions of the stem and branches of the kahikatea (*Podocarpus dacrydioides*), growing mixed with mosses and *Hepaticae*. and that it is a rare circumstance to find specimens anywhere near the ground. This may account for the small number of localities recorded up to the present time.

Bulbophyllum pygmaeum Lindl.

Mr. H. B. Matthews also states that in Mongonui County *B. pygmaeum* is found more plentifully on *Knightia excelsa* than on any other tree. I have also noticed its comparative abundance on *Knightia* in other districts.

Prasophyllum rufum R. Br.

Tutira, Hawke's Bay; *H. Guthrie-Smith!* Waimarino Plains, western side of Ruapehu; *E. Phillips Turner!*

Corysanthes Cheesemanii Hook. f.

Mr. H. B. Matthews sends a two-flowered specimen, collected in the vicinity of Kaitaia.

LXXXII. Liliaceae.

Herpolirion novae-zealandiae Hook. f.

At Kaikuri, about ten miles to the west of the Waitomo Caves, at an altitude of about 1,000 ft.; *E. Phillips Turner!* This is the first record to the north of Lake Taupo and the central volcanic plateau.

XCI. Cyperaceae.

Schoenus apogon Roem. & Schultes.

Near Cape Maria van Diemen, and on the slopes above Tapotopoto Bay, North Cape Peninsula; *H. Carse!* Not previously known from the north of Mongonui Harbour.

Cladium Huttoni T. Kirk.

Tauroa, near Ahipara, and also at Puheke, near Lake Ohia, both localities in Mongonui County; *H. Carse!*

Oreobolus pumilio R. Br. var. pectinatus C. B. Clarke.

Summit of Mount Hikurangi, East Cape district; altitude, 5,000 ft.; *Gerard Williams!*

Uncinia rubra Boott.

Kaikuri, near the Waitomo Caves; altitude, 1,000 ft.; *E. Phillips Turner!* Considerably to the north of the Taupo Plains, which was believed to be its northern limit.

XCII. Gramineae.

Paspalum Digitaria Poir.

Of late years this has increased enormously in the Lower Waikato, and in many places fringes the river and its tributaries for miles together. In dry seasons, when it can be easily reached by cattle, it is of considerable service, and is looked upon by the settlers as a valuable grass.

Festuca multinodis Petrie.

Rocky places on the raised beaches eastwards of Cape Turakirae, Cook Strait; *B. C. Aston* and *T. F. C.*

Asperella gracilis T. Kirk.

Mr. H. B. Matthews has sent me specimens collected by him near Kaitaia. It was not previously known north of Te Pahi, Kaipara.

XCIII. FILICES.

Doodia media R. Br.

Mr. H. Carse has forwarded crested specimens of this gathered at Maungatapere, Whangarei.

Asplenium Trichomanes Linn.

I am indebted to *Mr. E. Phillips Turner* for specimens collected on limestone rocks near the Waitomo Caves. This is a slight extension of its northern range. (See Trans. N.Z. Inst., vol. 43, 1911, p. 185.)

Nephrodium glabellum A. Cunn.

Specimens of this with the tips of the primary pinnae crested have been collected at Mangatete, Mongonui County, by *Mr. H. Carse.*

Polypodium Billardieri R. Br.

Mr. Bedgood, of Kaitaia, has collected a remarkable sport in which the tips of the pinnae are expanded and lobed or almost pinnatifid.

NATURALIZED PLANTS.

Ranunculus flammula Linn.

Vicinity of Kaitaia; *H. B. Matthews!* Has been previously recorded only from the Waiharakeke Stream, Piako. (See Trans. N.Z. Inst., vol. 39, 1907, p. 450.)

Reseda lutea Linn.

Slopes of Mount Eden, Auckland; *F. Neve!*

Polygala virgata Thunb.

Among fern and low tea-tree scrub at Mangatete, near Awanui; *H. Carse!* Edge of forest near Kaitaia; *Mrs. Foley!* In several places near Kihikihi, Waikato; *N. M. Lethbridge!* A common South African plant, now recorded for the first time from New Zealand. It is probably a garden escape, although I cannot learn that the species has been in cultivation in any of the localities quoted above.

Claytonia perfoliata Doun.

Karori, Wellington; *J. S. Tennant!* This is the first record for the North Island. Originally introduced into Europe from North America about the beginning of the nineteenth century, it has now become naturalized in many countries.

Tribulus terrestris Linn.

I am indebted to *Mr. F. Hutchinson* for a specimen of this, collected in pure shingle at Port Ahuriri, Hawke's Bay. So far as I am aware, it has

not been previously observed in New Zealand. It is a native of sandy shores in the south of Europe and north of Africa, but is now a common weed in many countries.

Psoralea pinnata Linn.

I am informed by *Mr. H. Oakley* that this has gone wild at Waipu, and threatens to become a serious nuisance. It is commonly cultivated in gardens, but I have not previously heard of its spreading spontaneously.

Lactuca scariola Linn.

Onehunga Railway-station yard; *J. P. Kalaugher!* Not previously recorded from New Zealand.

Jasione montana Linn.

Tutira Run, near the source of the Mohaka River, Hawke's Bay; *H. Guthrie-Smith!* This is the first recorded instance of this plant in New Zealand.

Echium plantagineum Linn.

Has been abundant on one farm at Kihikihi, Waikato, for more than forty years; *J. B. Hayes!* Has recently appeared in considerable quantity on the slopes of Mount Victoria, Devonport; *J. P. Kalaugher* I observed it in the vicinity of Auckland more than twenty years ago, but it seems to have died out in the original localities.

Hyoscyamus niger Linn.

Near Pakuranga, Auckland; *R. Green!* The only locality previously published for New Zealand is that of Wellington, by Mr. T. Kirk.

Verbena bonariensis Linn.

Near Kaitaia; *H. Carse!* Slopes of Mount Eden; *F. Neve!*

Euphorbia segetalis Linn.

On sand-dunes at Tauroa, near Ahipara; *R. H. Matthews* and *H. Carse!* Now recorded for the first time in the Southern Hemisphere. It is a native of southern Europe and north Africa, extending as far south as Madeira and the Canary Islands.

Euphorbia cyparissias Linn.

I am indebted to *Mr. J. W. Murphy*, of Christchurch, for specimens of this collected near Culverden, North Canterbury. As in the case of *E. segetalis*, it has not been previously recorded from the Southern Hemisphere.

Alnus glutinosa Linn.

Old trees of the alder have spontaneously appeared in not a few stations along the banks of the lower Waikato, from Huntly to within a few miles of the mouth of the river. Probably they have originated from seeds floated from Taupiri, where, I understand, it was planted by the missionaries prior to 1850. The willows which now form a continuous fringe along the banks of the river have doubtless originated from the same source.

Eichhornia crassipes Schlecht.

The well-known "water-hyacinth" has established itself in a lagoon at Te Aroha, according to information supplied to me by *Mr. F. Neve.* At

present it is in small quantity; but it should be kept under observation and not allowed to spread. It is well known that its introduction into Florida resulted in the blocking of steamer navigation in several slow-running rivers.

Hydrocleis nymphaeoides Buchen.

I am indebted to *Mr. Neve* for numerous specimens of this handsome water-plant, which he informs me is now plentiful in several lagoons or backwaters near the Thames River, at Te Aroha, and is apparently rapidly increasing. According to inquiries kindly made for me by Mr. Neve, it was planted nearly twenty years ago by a Mr. Wood in a lagoon on his property about a mile and a half from Te Aroha. In this locality it now covers an area of more than an acre in extent, and has become a considerable nuisance, blocking up drains and water-channels. The beauty of the flowers has induced several settlers to transfer it to other localities near Te Aroha. In all of these it is rapidly increasing, and there is every probability of its spread in suitable places in the Thames Valley. It is a common plant in South America, ranging from Venezuela to Buenos Ayres, and is now widely cultivated in gardens.

Polypogon fugax Nees.

This has spread very rapidly in the Auckland Provincial District, and is now common in most districts in brackish-water swamps.

ART. II.—*The Age and Growth of the Kauri* (Agathis australis).

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 3rd December, 1913.*]

THERE is a well-known tendency in human nature to exaggerate that which is really large, and, consciously or unconsciously, to make it appear even larger and more important than it really is. Even in such a matter as the height of the taller trees, their girth, and still more their estimated age, is this peculiarity evident. Take, for instance, the statements that have been made respecting the Dragon-tree of Orotava, in the Canary Islands. This celebrated tree, which was destroyed by a storm in 1851, had a diameter of over 26 ft., and was estimated by some early travellers to have an age of from eight thousand to ten thousand years. Later on these figures were reduced to five thousand or six thousand, and at the present time good authorities consider this estimate far too high. So also with respect to the well-known baobab (*Adansonia digitata*), which Humboldt speaks of as "being the oldest organic monument of our planet." In 1750 the French traveller Adanson calculated the age of a specimen observed at Senegal to be over five thousand years. Nowadays it is universally believed that this record is far too high, and was probably based more on vague conjecture than on actual measurement. Coming down to recent times, the immense size of the "big trees" of California (*Sequoia gigantea*) led to conjectures as to their age varying from three thousand to six thousand years. But when Professor Whitney, the State Geologist of California, took the first accurate measurements it was proved that a tree 24 ft. in diameter con-

tained no more than 1,255 annual rings. Later on a full-sized tree was felled in Fresno County which had a girth of 62 ft. at 8 ft. from the ground, and was 300 ft. in height. Two sections of its trunk were secured, one of which is set up in the Central Hall of the British Museum. Its annual rings have been carefully counted, and proved to be 1,335. It is not now considered probable that any of the existing or recently existing sequoias had a greater age than fifteen hundred years.

Similarly the height of the giant gum-trees of Australia was for many years persistently overestimated. In this respect I may appropriately quote some remarks by Dr. A. J. Ewart, given in his memoir "On the Ascent of Water in Trees" (Philosophical Transactions, vol. 199B). At page 367, speaking of the height of the tallest tree in Australia (called by him *Eucalyptus amygdalina*, but now more generally referred to Mueller's *E. regnans*), he states that the height of the trees has been greatly exaggerated. "Mueller in his Eucalyptographia gives the heights as observed by Walter (Cape Otway), Robinson (Mount Baw Baw), Howitt (Gippsland), D. Boyle (in the Dandenong Ranges), which are 415 ft., 471 ft., 410 ft., and 420 ft. respectively. None of the erect trees appears to have been properly measured, and Boyle's measurement was stated to have been made on a fallen tree from which the top was wanting. The accuracy of the last-named observer is sufficiently indicated by the fact that the height of a tree was first given by him as 525 ft., subsequently reduced to 466 ft., and proved on accurate measurement by Mr. Fuller in May, 1889, to be 220 ft. high and 48 ft. in girth. Various statements as to the existence of specially tall trees of over 350 ft. in height have all proved on proper measurement to be considerably exaggerated when the supposed giant was found. Many fallen giants with heights given as from 450 ft. to 500 ft. evaporated into thin air on the approach of accurate instruments and unbiased observers. The tallest trees are usually found in thick groves or in valleys. The trees of greatest girth are found in the open, but are of less height. The tallest trees measured by Perrin, Davidson, and Fuller were 271 ft., 294 ft., 296 ft., 297 ft., and 303 ft. respectively. The tallest Australian tree, therefore, hitherto accurately measured barely exceeds 300 ft.; and it is possible that some of the records from other countries, notably America, may suffer a similar diminution when accurately tested."

Seeing that the age and size of large forest-trees have been regularly overestimated in other countries, it could hardly be expected that New Zealand would escape similar exaggeration. The kauri pine, the largest of New Zealand trees, has a smaller average diameter than the "big trees" (*Sequoia gigantea*) of California. But the estimates which have been published of its age are almost as high, and careful writers, such as Mr. T. Kirk and Mr. W. N. Blair, have not hesitated to assign an age of "considerably over four thousand years" (Kirk) or three thousand six hundred years (Blair) to the largest example known; although neither of these gentlemen appears to have counted the annual rings of growth in even a single complete section. As specimens examined by myself many years ago were in direct conflict with these statements, I have been led to examine the question with some care, and have measured and counted the rings of growth in complete sections in various portions of the country. The deductions drawn from these measurements, and the general conclusions arrived at, I propose to present to the Institute in this memoir.

Before proceeding to give particulars of my own investigations it will be well to briefly state the opinions arrived at by other observers. The

earliest of these is Mr. T. Laslett, author of the well-known book "Timber and Timber-trees." Mr. Laslett, in his capacity as timber inspector to the Admiralty, made several visits to New Zealand during the years 1840–43, being attached to certain expeditions sent by the British Government for the purpose of procuring spars fit for the topmasts of line-of-battle ships. During these expeditions he had good opportunities of studying the kauri, and from his wide acquaintance with timber and timber-trees, as well as from his scientific training and experience, was well qualified to speak with authority. At pages 44–45 of his book he gives a tabular statement of the number of concentric circles or woody layers found in various timber-trees "within a radius of 3 in., 6 in., 9 in., 12 in., 15 in., 18 in., 21 in., and 24 in., measured from the pith, or centre," representing, of course, trees with a total diameter of double the radius. From an examination of four kauri sections he arrives at the conclusion that the average number of woody layers required to make 1 in. of wood for a full diameter of 24 in. would be 6·7 for each inch of the whole diameter, equivalent to 13·4 per inch of the radius alone. It will be seen that this represents a somewhat slower rate of growth than that which I have obtained from the examination of a much greater number of sections; but the difference is not very large. If Mr. Laslett's estimates had received proper consideration from subsequent writers many rash and unsupported statements would never have been made.

The next writer of note to deal with the age of the kauri was Dr. Hochstetter. In his well-known book, "New Zealand, its Physical Geography, Geology, and Natural History," he gives by far the best and most reliable popular account of the kauri that has yet been published. At page 147 he says, "The oldest and largest trunks attain a diameter of 15 ft., and a height of 100 ft. to the lowest branches, or from 150 ft. to 180 ft. to the top of the crown. Such trees are probably seven hundred to eight hundred years old. Having examined several trunk sections, I found, as the mean result, from ten to twelve rings to 1 in., although in some cases the rings attain a much greater thickness. In some few cases of rare occurrence I have even observed single rings of a thickness of 1 in. For the sawmill the woodcutters generally pick out trees of 4 ft. diameter, with trunks measuring from 60 ft. to 80 ft. to the crown. Such trees are probably two hundred and fifty to three hundred years old."

Hochstetter's estimate of "ten to twelve annual rings to 1 in." is intermediate between my own and Laslett's; but, on the other hand, his statement that trees with a diameter of 15 ft. "are probably from seven hundred to eight hundred years old" is somewhat under the mark, as it would imply only 8·0 rings for each inch of radius.

We now arrive at the views entertained by the late Mr. T. Kirk, a synopsis of which will be found on pages 144–45 of his "Forest Flora." He says, "A cross-section of a kauri felled in a free-growing condition usually exhibits from seven to thirteen concentric rings to each inch of radius: if we take ten rings as a fair average for growing timber, it would give three centuries as the age of a tree with a diameter of 5 ft. at the base. This rate of increase is supported by the little we know of the rate of growth of young trees. In the Auckland Domain trees planted twenty-two years ago are now 25 ft. high, with a circumference of 26 in., which shows greater rapidity of growth; but the trees are growing under very favourable conditions. Another tree planted twenty years ago is 20 ft. high, with a diameter [? circumference] of only 20 in." Now, all this is

very just and reasonable, and is evidently based on personal examination. His proposed average of ten annual rings to the inch is almost precisely the same as that obtained by myself (9·7). And his estimate of 300 years as the probable age of a tree with a diameter of 5 ft. at the base, if worked out on the average which my figures have yielded, would only be reduced to 291 years.

But, unfortunately, Kirk proceeds to make assumptions respecting the growth of larger trees, for which no sufficient evidence exists, and which are altogether opposed to the information I have been able to obtain. He goes on to say, "The wood of the kauri remains sound long after it has passed its maximum rate of growth; but the newly formed wood cylinders are very thin, while the immense pressure exerted by the outer cylinders consolidates the inner portion of the trunk so that the number of rings to an inch is greatly increased. I have counted over thirty rings to an inch in some gigantic trunks, so that, assuming each ring to represent only a year's growth, the age of a tree 7 ft. in diameter must be 1,260 years. The gigantic specimen at Mercury Bay, which is 80 ft. to the lowest branch and 24 ft. in diameter, must be considerably over 4,000 years; and the fine specimen at Maunganui Bluff, which is 66 ft. in circumference, would not be less than 3,600 years."

Now, the whole of these estimates rest on two assumptions: (1.) That as the tree approaches maturity the newly formed wood cylinders become very thin. This statement is in direct variance with my own measurements of no small number of trees up to 11 ft. in diameter. (2.) That the pressure exerted by the outer cylinders consolidates the inner portion of the trunk so that the number of rings to an inch of radius is greatly increased. But my measurements do not show that the inner rings are "consolidated" in trees of large size; and, in addition, I believe I am correct in stating that authorities in vegetable physiology do not countenance the idea of marked compression of woody tissue in the interior of a trunk due to the successive formation of exterior annual rings.

I have already said that the statement made by Kirk to the effect that a tree 5 ft. in diameter would have an average of ten annual rings for each inch of radius, and be 300 years old, must be accepted as a close approximation to the truth. But I fail to see how he can reconcile with it the statement made in the very next paragraph that a tree only 2 ft. wider, or 7 ft. in diameter, would have an age of 1,260 years, with an average of thirty rings for each inch of radius. This is equivalent to saying that during the formation of the additional foot of radius the rate of growth had been diminished to a third of what it previously was. Kirk's contention also implies that the 300 rings which in the 5 ft. tree occupied the radius of 2 ft. 6 in. had been squeezed in the 7 ft. tree into a space of 10 in.! It is unbelievable that the woody layers of a 5 ft. tree could suffer any such compression. But if not, then the 960 annual rings required to make up the full number of 1,260 must be crowded into the extra foot of radius, at the rate of 80 per inch! Not only is such an exceptionally slow rate of growth unknown in the *Coniferae*, but even no approximation to it has ever been recorded. It is quite clear that Kirk's two estimates are inconsistent one with the other. If the first is accepted, then the second must be swept away.

Since Mr. Kirk wrote the "Forest Flora" in 1889 no one has attempted to treat the question in the only accurate manner—that of counting the annual rings of growth in a sufficiently large number of sections of different

diameters and from different localities. In this manner alone can a reliable average of the rate of growth be obtained. It is true that numerous references to the age of the kauri have been published; but apart from some on the rate of growth of planted trees, these consist either of vague statements to the effect that mature trees are of immense antiquity, or of equally vague assertions that they attain an age of several thousand years, periods ranging from three thousand to five thousand years being freely mentioned. My own doubts as to the accuracy of the common belief date back as far as 1884, when I counted the rings of growth in a tree 4 ft. in diameter cut down near Whangarei. To my surprise, I found that the tree had only 188 rings, or 7·8 per inch of its radius. A few years later I examined another tree at Coromandel, with a diameter of 5 ft. 6 in., which proved to have 280 rings, an average of 8·5 per inch. Other trees were counted from time to time; but during the last two years I have been able to obtain quite a number of accurate measurements, amply sufficient, I think, to form the foundation of some general conclusions.

Before proceeding to arrange the measurements in tabular form it is well to give an outline of the plan followed in obtaining them. In the first place, it was soon ascertained that if reasonable accuracy were desired it was necessary to examine the trees as soon as possible after they had been cut down. Even after the lapse of a few months only, the surface of the stump becomes covered with numerous cracks, some in a radial direction, or across the rings of growth, and others tangential, or parallel with them. These tiny cracks greatly increase the difficulty in counting the rings. Again, the surface of the stump dries very rapidly, becoming hard and difficult to plane, necessitating constant sharpening of the tool, while the cracks interfere with the production of a smooth surface. In the majority of cases, therefore, a recently cut stump was selected. A track about 4 in. wide was then carefully planed from the circumference to the pith. The majority of the rings could then be counted without any further preparation; but in order to render the whole of them evident the surface was either watered or treated with oil or stain, the plan followed depending on the circumstances of the case. On the whole, I have found that linseed-oil well rubbed in along the smoothly planed track was a perfectly satisfactory mode of treatment. Taking the pith as the starting-point, the rings were usually counted in tens, each group of ten being marked off separately, and the space occupied by it measured. In a similar manner each hundred rings was separately distinguished. The advantage gained by doing this is that when the count is completed it is easy to prepare a chart giving the position of every group of ten or any multiple of ten along the measured radius of the tree, and thus to indicate at a glance any irregularity in the disposition of the rings. And it may be mentioned that such irregularities frequently occur.

Before actually commencing to count the rings the greatest and smallest diameters of the trunk were measured, and the position of the pith noted. It is very seldom that the pith is central. In most cases it is decidedly eccentric, and sometimes largely so. In one instance a tree 5 ft. in diameter had its pith only 1 ft. 3 in. from the southern side of the tree. Usually (but not invariably) the centre is nearest to the southern side of the tree, implying that the cambium layer has been most active on the northern side, or towards the sun. Care was also taken to notice the position of the tree as regards its environment—whether sheltered from the wind or sun or exposed to one or both of them; whether the tree was crowded among

other trees of nearly the same age (in which case the rate of growth in diameter was usually slower, although the height of the tree was probably greater). In short, any facts that appeared to be serviceable in the consideration of the question were noted and tabulated.

The total number of trees included in the following table is twenty-nine. Of these Nos. 1 to 7 are cultivated trees, the date of planting of which is accurately known. The number of annual rings given for these specimens is the number of years since they were planted, plus three, the estimated age when planted. The rings have been actually counted in a sector of the stem in the remaining twenty-two; and with the exception of No. 9, which is taken from Mr. Laslett's book, "Timber and Timber-trees" (p. 45), and the last four (Nos. 26 to 29), for which I am indebted to the kindness of Mr. W. A. Nisbet, the countings have been taken by myself. I have, however, to thank my friends Mr. J. Stewart, Mr. T. Herbert, and Mr. C. Spencer for kind assistance with several sections.

TABLE SHOWING THE ANNUAL RINGS OF GROWTH AND THEIR AVERAGE TO THE RADIUS OF CERTAIN SECTIONS OF KAURI-TREES OF GIVEN DIAMETER.

No.	Diameter of Tree.	Number of Annual Rings.	Average Number of Rings for Each Inch of Radius.	Locality.	Authority.
	Ft. in.				
1	0 8·6	25	5·8	Auckland Domain..	J. Baber.
2	0 10·6	43	8·1	Parawai, Thames ..	J. W. Hall.
3	0 7·6	43	11·3	,, ,, ..	,,
4	0 9·0	43	9·5	,, ,, ..	,,
5	0 8·6	38	8·9	,, ,, ..	,,
6	0 5·6	38	13·5	,, ,, ..	,,
7	0 10·3	26	5·1	Remuera.. ..	Hon. E. Mitchelson.
8	1 0	42	7·0	Auckland Domain..	J. Stewart.
9	2 0	161	13·4	(?)	T. Laslett.
10	11 0	476	7·2	Waitakerei ..	T. Herbert and T. F. C.
11	4 4	213	8·2	,, ..	,,
12	5 0	280	9·3	,, ..	,,
13	5 7	270	8·1	,, ..	,,
14	8 0	455	9·4	Mangawai ..	J. Stewart and T. F. C.
15	4 0	188	7·8	Whangarei ..	T. F. C.
16	5 6	280	8·5	Coromandel ..	,,
17	7 7	448	9·8	Waitakerei ..	C. Spencer and T. F. C.
18	5 11	320	9·0	,, ..	,,
19	4 2	195	7·8	,, ..	,,
20	3 8	153	7·0	,, ..	,,
21	3 3	158	8·1	,, ..	T. F. C.
22	3 10	197	8·5	,, ..	,,
23	7 5	352	7·9	,, ..	,,
24	4 1	220	9·0	,, ..	,,
25	3 1	241	13·0	,, ..	,,
26	3 1	353	19·0	Near Paeroa ..	W. A. Nisbet.
27	6 3	545	14·5	,, ..	,,
28	7 8	627	13·6	,, ..	,,
29	8 4	705	14·0	,, ..	,,
	Total ..	..	282·3		
	Average ..	..	9·7		

It thus appears that the examination of twenty-nine sections gives 9·7 as the mean number of annual rings for each inch of radius. An average based upon such a large number of examples cannot be very far from the truth, and we may therefore proceed with some degree of confidence to compare it with the estimates given by Kirk in the "Forest Flora."

Let us take first of all the gigantic tree at Mercury Bay, originally reported and measured by Laslett (see "Timber and Timber-trees," page 389), and subsequently mentioned by Kirk and others. I have already quoted Kirk's opinion that its age "must be considerably over four thousand years." The exact figures worked out on his own basis of thirty annual rings per inch would be 4,320. But according to my average of 9·7 rings per inch its age would not exceed 1,396 years. And I prefer to take an estimate which, at any rate, is based upon the measurement of a considerable number of examples, in place of accepting one which is little more than a bare assumption. I consider that Kirk's figures are at least three times the proper amount. Similarly, the specimen at Maunganui Bluff, which is 22 ft. in diameter, and which according to Kirk has an age of 3,960 years, under my views would not exceed 1,280 years. Kirk's assertion that "the age of a tree 7 ft. in diameter must be 1,260 years" I have already combated on the ground that such an estimate is altogether inconsistent with his very reasonable and correct view that a 5 ft. tree would be 300 years old. Worked out on my average of 9·7, the age of the 7 ft. tree would be 407 years, and that of the 5 ft. tree 291 years. The great majority of the kauri-trees that are now cut for sawing range from 3 ft. to 8 ft., and the age of such trees, according to my calculations, and subject only to a very narrow limit of error, would be 174 years for the 3 ft. tree and 465 years for the 8 ft. one.

It may be objected that some weight ought to be attached to Kirk's view that in trees of large size the increment of woody tissue formed each year would progressively decline. But as long as the environment of the tree is suitable, and the production of foliage is maintained, there is no reason why that should take place. It is well known that a tree does not cease growing when it arrives at maturity. Professor Marshall Ward says that "as long as it is alive it continues to increase in bulk by the addition of the annual layers developed by the cambium; but when maturity is once passed each succeeding year produces a certain amount of deterioration at the centre." This deterioration ultimately leads to the tree becoming hollow, but that does not prevent the cambium from forming additional layers. Strasburger says ("Text-book of Botany," p. 239), "All that is actually visible of a thousand-year-old oak is at most but a few years old. The older parts are dead, and are either concealed within the tree, as the pith and wood, or have been discarded like the primary cortex. The cells of the original growing-point have alone remained the whole time alive. They continue their growth and cell-division as long as the tree exists." It is almost needless to say that in most parts of the world numerous examples have been cited of hollow trees which are known to have continued their growth for long periods. With respect to the kauri, in trees of large size it is quite common to find the lower part of the trunk hollow. While engaged in measuring the sections just tabulated I noticed several instances the exact age of which I was unable to determine on account of decaying wood or cavities in the centre. All these trunks had well-developed rings of growth near the circumference. One in particular, which measured

8 ft. 3 in. in diameter, and which had a cavity in the centre quite 18 in. across, had its external rings of growth perfectly well developed, the last twenty-five occupying a space of very nearly $2\frac{1}{2}$ in., a rate of growth equivalent to 10·0 rings per inch of radius. This proportion is only very slightly under my general average of 9·7, and is well within the range of variation likely to occur.

A further word or two may be expected in reference to Kirk's idea that "the immense pressure exerted by the outer cylinders consolidates the inner part of the trunk so that the number of rings to the inch is greatly increased." But in making this statement he overlooked the immense strength and rigidity possessed by a column of woody tissue like that of a young kauri, say, 250 years of age. The already completed rings of growth, and especially those constituting the heart-wood, or duramen, have had the walls of their tissues thickened and hardened to such an extent as to constitute a framework, or skeleton, capable of withstanding any pressure that can be exercised by a newly formed woody layer. No doubt each new layer during its formation is subjected to varying strains and stresses, which modify its structure, and which, among other things, produce the well-known differences between the spring and autumn wood; but room for its actual formation is provided by the expansion of the inner cortical tissues, and the consequent fissuring or throwing-off (as in the case of the kauri) of the dead outer cortex. I conclude that Kirk was mistaken in supposing that previously formed annual rings could be materially reduced in thickness by the formation of rings of later growth, and submit the following experimental proof. The tabular statement already given shows the annual rings of growth in twenty-nine sections varying from 6 in. to 11 ft. in diameter. I propose to divide these sections into four groups, as follows: First, those with a diameter under 2 ft.; second, those from 2 ft. to 4 ft.; third, from 4 ft. to 6 ft.; fourth, from 6 ft. to 11 ft. The result is seen in the subjoined table.

Group 1. Under 2 ft. Diameter.		Group 2. 2 ft. to 4 ft. Diameter.		Group 3. 4 ft. to 6 ft. Diameter.		Group 4. 6 ft. to 11 ft. Diameter.	
Total Annual Rings for each Inch of Radius for Eight Sections.	Average for the Whole Group.	Total Annual Rings for each Inch of Radius for Seven Sections.	Average for the Whole Group.	Total Annual Rings for each Inch of Radius for Seven Sections.	Average for the Whole Group.	Total Annual Rings for each Inch of Radius for Seven Sections.	Average for the Whole Group.
69·2	8·6	76·8	10·9	59·9	8·5	76·4	10·9

General average for the whole of the groups: 9·7.

The above table shows no evidence of the number of rings to an inch being "greatly increased" in mature trees The averages for the various groups vary by only 2·4; and the average for trees between 6 ft. and 11 ft. in diameter, which would surely be called mature, is precisely the same (10·9) as that for trees between 2 ft. and 4 ft., and is very far removed from Kirk's suggested rate of thirty per inch for a 7 ft. tree.

Irregularities in the rate of growth of individual trees, however, are not uncommon, and may occur at any period of the life of the tree. It may be interesting to give a table of the rate of growth of an 11 ft. tree, the largest I have measured, and which, curiously enough, was also the most irregular in growth. For comparison I have included a similar table of

a tree, 5 ft. 11 in. in diameter, in which the disposition of the rings was remarkably regular.

Rate of Growth of Kauri-tree 11 ft. in Diameter, measured on the narrowest radius (52·22 in.) from the pith to the circumference. (On account of the scarf made in cutting down the tree it would have been difficult to measure the tree on the longest radius.)		Rate of Growth of Kauri-tree 5 ft. 11 in. in Diameter, measured on the radius of 35·92 in.	
Rings of Growth (equal to Years of Age), arranged in Groups of 25.	Space in Inches occupied by each Group of Rings.	Rings of Growth (equal to Years of Age), arranged in Groups of 25.	Space in Inches occupied by each Group of Rings.
25	1·00	25	2·50
50	1·12	50	3·00
75	3·00	75	3·25
100	3·50	100	3·25
125	3·00	125	3·12
150	2·00	150	3·62
175	3·50	175	3·12
200	2·75	200	2·62
225	3·75	225	3·00
250	6·62	250	2·62
275	4·62	275	2·25
300	3·75	300	2·12
325	2·50	320	1·45
350	3·25	..	..
375	2·75	..	..
400	2·62	..	..
425	3·12	..	..
450	0·75	..	..
476	1·18	..	..
Age of tree, 476 years. Average number of rings per inch of radius (5 ft. 6 in.), 7·2.		Age of tree, 320 years. Average number of rings per inch of radius (2 ft. 11 in.), 9·1.	

Comparing these two tables, the first point to notice is the great difference in the rate of growth of the two trees during the first fifty years. The 11 ft. tree produced only 2·12 in. of radius during this period, showing an average of 23·6 rings per inch of radius; while the smaller tree built up 5·5 in. of radius, with an average of 9·09 per inch, its rate of growth being approximately two and a half times as great. But the rate of growth of a young kauri probably depends very largely on how far it is crowded by other trees. In support of this view, Mr. J. W. Hall, of Thames, has drawn my attention to the different behaviour of two trees of equal age in his plantation at Parawai (Nos. 5 and 6 of my tabular list). No. 5, planted in an open situation, has formed 4·3 in. of radius in thirty-eight years; No. 6, much crowded by other trees, had only produced 2·8 in. in the same period. The number of rings per inch of radius in these two trees works out at 8·9 and 13·5 respectively.

The most interesting peculiarity disclosed by the ring measurement of the 11 ft. tree is the enormous increase of growth which took place between the 225th and 250th years, when no less than 6·62 in. of radius, equivalent to 13·24 in. of diameter, was formed, being at the rate of 3·7 rings for each inch. This is the largest rate of growth for a series of rings that I have observed, although single rings are sometimes seen from half an inch

to nearly an inch in diameter. The rate of growth continued very high for the next group of twenty-five rings, 4·62 in. of radius being built up, and was considerably above the average in the following one. During the seventy-five years covered by these three groups the tree increased its diameter by 2 ft. 6 in.

After the 425th year of the age of the tree, or fifty-one years before the present time (1913), a remarkably sudden slackening in the rate of growth took place, only ¾ in. of woody tissue being formed during the next twenty-five years, although 3·12 in. had been produced during the previous twenty-five. The rate did not nearly recover itself before the tree was cut down, the increase of woody tissue during the last twenty-six years occupying only 1·18 in. I was able to prove, however, that the slackening in growth was mainly a local peculiarity, confined to one portion of the circumference of the stem, for by planing to the right and left of the track along which the measurements had been made the crowded rings were seen to gradually open out until they occupied a greater diameter.

My main object in drawing attention to the peculiarities of the 11 ft. tree is to show how dangerous it is to estimate the age of any tree from counting the annual rings of part of a section only. If, for instance, the rings in the present example were known for only the 5 in. nearest the centre, or the 5 in. nearest the circumference, then for those portions the rate of fifteen rings per inch could be established, and, calculating on that basis alone, the age of the tree would be 990 years. On the other hand, if a portion in the centre had been selected—say, from the 225th to the 300th rings—then the average number of rings per inch would not exceed five, and the age of the tree would work out at 330 years only. On an actual count of the whole of the rings, the age of the tree was ascertained to be 476 years, the percentage of the annual rings to each inch of the radius being 7·2.

One point of some importance still remains to be mentioned. At page 144 of the "Forest Flora" Mr. Kirk says, "It is uncertain whether the kauri forms only a single cylinder of wood during each year or more: the balance of evidence is in favour of the latter view." Kirk nowhere states the nature of this evidence; nor does he act upon the belief in his calculations as to the probable age of the tree, all of which are based on the assumption that only one cylinder is produced in each year. Obviously, the rings of growth would be of little value for determining the age of the tree if there was any uncertainty as to their being of yearly production. Fortunately, however, this uncertainty has been removed by direct evidence. In the year 1865 several young kauri-trees and certain New Zealand taxads were planted in the Auckland Domain. In 1905 it became necessary to remove some of them, and at my suggestion Mr. James Stewart obtained cross-sections of the trunks. In all cases the number of concentric rings of growth agreed with the number of years since the trees were planted. Mr. Stewart's results, which are embodied in a paper printed in our Transactions (vol. 38, p. 374) may be taken as proving that the New Zealand gymnosperms do not produce more than a single well-defined cylinder of woody tissue in each year.

The conclusions that can be drawn from this investigation may be summarized as follows:—

1. That the statements made regarding the age and rate of growth of the kauri have for the most part been greatly overestimated, and particularly so for trees exceeding 5 ft. or 6 ft. in diameter.

2. That the number of measurements of trees of all sizes under 12 ft. diameter is now sufficiently large to admit of the determination of an average rate of growth, and that this rate can be stated with some confidence at 9·7 years for every inch of the radius of the tree.

3. That although the greater number of examples will be found in the neighbourhood of the general average, marked deviations may be occasionally seen; although, as these occur both above and below the average, they do not materially influence the position.

4. That as regards trees of greater diameter than 12 ft. some slight uncertainty may still exist as to their age, on account of the total absence of measured sections. But as no progressive decline in the diameter of the annual rings has been found in the largest trees yet examined, and as a tree of very large diameter is almost certainly a tree that has grown unusually fast at one period of its life (see previous references to the 11 ft. tree), there seems to be no reason for assuming that the average rate of growth is materially different.

5. That although the kauri is not so excessively slow in its growth as has been supposed, it is much slower than most trees of economic value. A tree 2 ft. in diameter would have an average age of 116 years; one of 3 ft., 174 years; and one of 4 ft. would be 232 years old. Periods like these are much too long to offer any hope of monetary return from the planting of kauri, even if there were not other reasons to advance against such an undertaking.

ART. III.—*Notes on* Pittosporum Dallii.

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 3rd December, 1913.*]

Pittosporum Dallii, which is one of the most distinct species of the genus, was discovered by the late Mr. J. Dall in 1905 in the rugged mountainous country at the back of Collingwood, north-west Nelson. Unfortunately, imperfect fruiting specimens were alone obtained, and although I published the plant in the Appendix to the "Manual of the New Zealand Flora" (p. 1134) the description was in many respects incomplete. It was Mr. Dall's intention to revisit the locality in search of flowers; but an unfortunate accident, from the effects of which he never completely recovered, made it impossible for him to undertake the laborious journey which would have been necessary, and he died in 1912 without obtaining any additional material. Previous to his death, however, he had furnished particulars of the locality to my friend Mr. F. G. Gibbs, so well known from his researches into the botany of the Nelson Provincial District. During the past summer Mr. Gibbs was fortunate enough to find the plant, and to bring away a good series of flowering specimens, together with other information respecting it. From this material I have been able to draw up a much more complete description, and to give some other information respecting the species.

Pittosporum Dallii Cheesem., Man. N.Z. Fl. App. 1134.

A small round-topped tree from 12 ft. to 18 ft. high; trunk sometimes 8 in. diam.; bark of stem and larger branches light grey. Branchlets stout,

often subwhorled, glabrous; bark reddish. Leaves towards the tips of the branchlets, the lower alternate, the upper subopposite or whorled, 2–4 in. long, $\frac{1}{2}$–$1\frac{1}{2}$ in. broad, narrow elliptic-oblong or elliptic-lanceolate, acute or somewhat acuminate, rigidly coriaceous, quite glabrous or the very young ones sparingly tomentose, sharply and coarsely serrate; midrib stout, prominent above; veins finely reticulated; petioles stout, reddish, $\frac{1}{2}$–$\frac{3}{4}$ in. long. Flowers numerous, white, fragrant, arranged in a dense terminal compound cyme 1–2 in. diam.; bracts many, deciduous, but conspicuous in the early flowering stage; the lower large, membranous, brownish, oblong or oblong-lanceolate, often 1 in. long; the upper gradually becoming smaller and narrower; the uppermost narrow subulate-lanceolate, $\frac{1}{3}$–$\frac{1}{2}$ in. long; both bracts and pedicels more or less silky-tomentose. Flowers $\frac{1}{4}$–$\frac{2}{3}$ in. long, $\frac{1}{2}$ in. diam. when fully expanded; sepals $\frac{1}{2}$–$\frac{2}{3}$ the length of the corolla, narrow linear-subulate, attenuate at the tips; petals linear-obovate or linear-oblong, obtuse, conspicuously veined. Stamens included; anthers rather large, bright yellow. Ovary shortly stipitate, with very numerous ovules to each placenta; style stout, cylindrical. Capsules forming dense clusters at the tips of the branchlets, $\frac{1}{2}$ in. long, elliptic-oblong, apiculate, glabrous, 2-valved; valves woody. Seeds numerous, immersed in a viscid gluten; often persistent after the fall of the valves as a viscid ball at the top of the pedicel.

Hab.—South Island: Nelson—Mountains behind Collingwood, at Specimen Creek and Snow's Valley, near Boulder Lake; altitude, 3,500 ft. Flowers in January.

P. Dallii is not closely related to any other species, either in New Zealand or elsewhere. It is the only New Zealand species with regularly serrate leaves; it is the only species we have with white flowers; and, with the single exception of *P. eugenioides*, no other of our species has such a well-developed inflorescence. When in flower it must be a very beautiful plant; in fact, Mr. Gibbs goes so far as to say that "it is far more handsome than any of the other *Pittosporums* that I have seen." The fragrance of the flowers is another attractive characteristic, although, as Mr. Gibbs remarks, it does not equal *P. patulum* in that respect.

P. Dallii appears to be rare in its only known habitat. Mr. Gibbs informs me that he saw only three or four fully adult trees, which were growing in the open on a grass-covered hillside above Specimen Creek, at an altitude of about 3,500 ft., but he has reason to believe that there were several others higher up the hill. A number of young trees were seen, however, in a small patch of bush not far distant, and others were noticed in the bush on the eastern side of Snow's Valley. No seedlings were seen; so it is not known whether the young states have heterophyllous foliage like *P. patulum* or *P. virgatum*. Mr. Gibbs remarks that the large bracts present a somewhat conspicuous appearance, forming a kind of involucre surrounding the flower-heads.

P. Dallii is evidently well worth cultivation as a garden-plant, and from the nature of its habitat will probably prove hardy all through the Dominion, and possibly in the south of England. The remarks made by Mr. Gibbs as to the fragrance of its flowers brings to mind the fact that *P. Tobira*, a native of Japan, is largely grown in France for the sake of its fragrant white flowers, which are sold in great quantities in the Paris flower-markets.

ART. IV.—*Description of a New* Celmisia.

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 3rd December, 1913.*]

EARLY in January, 1912, I received a packet of plants collected by Mr. P. G. Morgan, the Director of the Geological Survey, in the Westport district, and among the specimens I at once noticed a curious *Celmisia* that appeared to possess indubitable claims to be considered a distinct species. Unfortunately, Mr. Morgan has not been able to recall the exact locality in which he gathered the plant, but as it must be somewhere in the narrow district between Westport and the Ngakawau River the want of more precise knowledge is not of very great importance. Mr. Morgan has done excellent service in collecting the plants of north-west Nelson, and I have pleasure in dedicating the species to him.

Celmisia Morgani Cheesem. n. sp.

C. longifolia Cass. var. *graminifolia* T. Kirk affinis, sed differt foliis flaccidis, multo majoribus et latioribus.

Folia numerosa, 15–50 cm. longa, 1·2–4 cm. lata, lineari-lanceolata, acuminata, membranacea, flaccida, supra glabrata, subtus sericeo-tomentosa et nervo medio prominente. Petioli graciles, basi latissime scarioso-membranacei et vaginantes. Scapi 2–4, graciles. Capitula majuscula, 2–3·5 cm. diam. Achaenia glabrata.

Hab.—South Island: Between Westport and the Ngakawau River, *P. G. Morgan!* near the mouth of the Ngakawau River, *D. Petrie!* (much more coriaceous and tomentose).

Leaves numerous, tufted, 6–20 in. long including the petiole, $\frac{1}{2}$–$1\frac{1}{4}$ in. wide; blade narrow linear-lanceolate, narrowed very gradually towards the base into an exceedingly slender petiole, above the middle tapering into an acuminate point, membranous, often almost flaccid, rarely subcoriaceous; upper surface glabrous or nearly so, usually smooth but sometimes furrowed when dry; under-surface clothed with thin white and silvery tomentum through which the veins are frequently visible; midrib evident beneath, often glabrous; petiole long and slender, greenish or greenish-purple, gradually expanded below into a thin and membranous cottony sheath sometimes $\frac{1}{2}$ in. wide or even more. Scapes several, equalling or exceeding the leaves, very slender, usually more or less white and cottony but sometimes almost glabrous; bracts numerous, narrow-linear, the lowest sometimes 4 in. long, the upper gradually becoming smaller, the uppermost under $\frac{1}{2}$ in. Heads $\frac{3}{4}$–$1\frac{1}{2}$ in. in diameter; involucral bracts linear-subulate, glabrous or cottony, green or purplish-green. Rays numerous, rather long and narrow. Achene linear, glabrous.

This clearly belongs to the same group of species as *C. longifolia*, and is not very far removed from Kirk's variety *graminifolia*, a plant which I suspect will some day have to be restored to specific rank. But it has much larger broader and thinner leaves, with remarkably slender petioles, and is quite as distinct from *C. longifolia* as *C. Adamsii* and *C. linearis*. The whole of the forms at present included in *C. longifolia* require study in the field; and their identification as a species with the original *C. longifolia* of Australia should be re-examined.

Art. V.—*Notes on the Botany of Routeburn Valley and Lake Harris Saddle.*

By D. L. Poppelwell.

[*Read before the Otago Institute, 7th October, 1913.*]

During the Christmas holidays of 1912 Mrs. Poppelwell and myself spent the period from the 27th December, 1912, to the 1st January, 1913, at Routeburn Hut, during which time we twice visited Lake Harris Saddle, and took notes of the botany of the valley generally.

Although this locality has frequently been visited by botanists, I can find no published description or list of its plants. I propose, therefore, without dealing exhaustively with the various plant associations, to describe some striking characteristics of the plant covering, and to give a list of the plants noted by me. There are also some peculiarities regarding the distribution of the plants in the locality which are interesting as much on account of what is missing from the associations as on account of what is present.

Lower Routeburn Valley.

The forest in this valley is almost entirely a beech one, and, as is usual, there is not much undergrowth. Here and there, however, along the damp gullies there are found such species as *Carpodetus serratus*, *Gaya Lyallii*, *Coprosma lucida*, *Olearia nitida*, *Nothopanax simplex*, *N. Edgerleyi*, *N. Colensoi*, *Griselinia littoralis*, *Senecio elaeagnifolius*, *Muehlenbeckia complexa*, *Phyllocladus alpinus*, *Podocarpus Hallii*, and a few others. The principal ferns are *Hymenophyllum demissum*, *Histiopteris incisa*, *Blechnum penna marina*, *Polypodium australe*, *Polystichum vestitum*, *Asplenium flaccidum*, *A. Richardi* (?), and *Blechnum fluviatile* (rare).

Of the smaller plants in the lower open valley glades and forest the principal consisted of *Acaena Sanguisorbae*, *A. microphylla*, *Muehlenbeckia axillaris*, *Wahlenbergia saxicola*, *Veronica Lyallii*, *Lagenophora petiolata*, *Luzuriaga marginata* (rare), *Coriaria angustissima*, *Ranunculus lappaceus*, *Helichrysum bellidioides*, *Hydrocotyle novae-zealandiae*, *Claytonia australasica*, *Viola Cunninghamii*, *Ranunculus hirtus*, *Angelica Gingidium*, *Anisotome brevistyle*, *Gastrodia Cunninghamii*, *Urtica incisa*, *Geum parviflorum*, and *Craspedia uniflora*. On the Routeburn Flat I noted *Poa Colensoi*, *Agropyron scabrum*, *Celmisia longifolia*, *Viola Cunninghamii*, *Cotula dioica*, *C. squalida*, *Cardamine heterophylla*, *Craspedia uniflora*, *Microseris Forsteri*, *Senecio Lyallii*, and *Myosotis macrantha*, the two latter on the creek-banks, with several species of *Epilobium*—i.e., *E. pubens*, *E. pycnostachyum*, *E. linnaeoides*, *E. rotundifolium*, and *E. melanocaulon*.

The Upper Routeburn Valley.

Just where the track emerges from the forest, at a height of about 3,300 ft., a magnificent view of the alpine scrub is obtainable, and as its association differs from most others in this locality it is worth describing. It is exceedingly dense and externally is rounded and smooth, but of various colours. The prevailing colours are green, brown, and white. Perhaps the brown is the most marked. This is brought about by the abundance of *Podocarpus nivalis*, which is very plentiful, especially in the lower part of the scrub. Higher up a greenish-brown tinge is given by *Dracophyllum*

uniflorum. The white arises from the great abundance of bloom on the *Veronicas.* These consist principally of *V. buxifolia, V. subalpina,* and *V. monticola,* the forms varying in a most bewildering way. *Veronica Hectori* is also plentiful, and *Cassinia Vauvilliersii* is abundant. The damp rocky faces are white with the magnificent *Ranunculus Lyallii, Celmisias* of various kinds, and *Anisotome.* Here and there is a plant of *Phyllocladus alpinus,* and a dark patch of *Polystichum vestitum.* Coming to details, the principal *Celmisias* are *C. Petrei* (plentiful), *C. coriacea, C. discolor, C. incana, C. petiolata,* and *C. verbascifolia ; Senecio Lyallii* and *S. scorzoneroides* are also abundant. The latter seem to be growing very luxuriantly, the leaves in many cases being over 2 in. broad. *Bulbinella Hookeri* is also plentiful, as is *Gaultheria rupestris. Ourisia macrophylla* and *O. caespitosa* are also present, but not in great abundance. *Olearia moschata* is common, and also *Coriaria angustissima, Senecio elaeagnifolius, Aciphylla Colensoi,* with *Lycopodium volubile, L. ramulosum,* and *L. fastigiatum.* Among other plants noted in this association were *Coprosma cuneata, C. parviflora, C. serrulata, Phormium Cookianum, Raoulia grandiflora, Helichrysum grandiceps,* and *Dracophyllum Traversii,* which latter constituted a marked red-brown patch.

Farther up the valley it was interesting to note how *Olearia moschata,* by its light-grey foliage and rounded appearance, dominated the association by creating a strong contrast with the darker *Veronicas* and *Podocarpus nivalis.*

I do not propose to further describe the general plant formation of the valley, but in the attached list have described where the various species noted are found.

CONCLUSION.

Appended is a list of plants noted, which with about a dozen reported by other observers but not observed by me makes up a total of 205 species, spread over 100 genera, and including forty-seven orders.

The list shows certain pecularities somewhat difficult to account for. It will be seen, for instance, that neither *Asplenium bulbiferum* nor *Blechnum discolor* appear in it. The former is one of our commonest ferns in damp bush, and I offer no theory for its absence. *Blechnum discolor* generally covers the floor of dry open forests, and perhaps its absence is attributable to the closeness of the beech forest shutting out the light and the superabundance of the rainfall in this locality. It is singular, however, that this fern is plentiful in the beech forest in the Dart Valley, above Kinloch, only about twelve miles away.

The great number of species in the locality can, I think, be traced to the abundance of the western rainfall and the wind-sheltered nature of the Lake Harris locality. The form of *Celmisia coriacea* is here a very strong-growing one. Its lanceolate leaves reach 18 in. or more in length, and are sinuate at the edges. The common form on the drier mountains farther east is not nearly so robust, and the leaves are stiffer in shape and more closely covered with silvery tomentum on both sides. The abundance of *Celmisa Petriei* is also marked, while on the saddle itself *C. Walkeri, C. laricifolia,* and *Forstera sedifolia* are most abundant plants, covering the ground like a sward over a considerable area. Among the *Veronicas* are numerous forms that seem to connect *V. buxifolia* through *V. monticola* (*V. Traversii* Cheeseman ?) and *V. glaucophylla* with *V. subalpina. V. propinqua,* a common plant of the drier eastern mountains, seems to be absent from this valley.

LIST OF PLANTS NOTED AT ROUTEBURN.

Pteridophyta.

Hymenophyllaceae.

Hymenophyllum demissum (Forst. f.) Sw. Common in forest.

Polypodiaceae.

Polystichum vestitum (Forst. f.) Presl. Forest clearings.
—— *cystostegia* (Hook.) J. B. Armstg. Crevices of rocks.
Asplenium flaccidum Forst. f. Epiphytic in forest.
—— *Richardi* Hook. f. In forest; rare.
Blechnum penna marina (Poir) Kuhn. Common on banks.
—— *capense* (L.) Schlecht. Rare; in forest.
Hypolepis millefolium Hook. Forest clearings; not uncommon.
Histiopteris incisa (Thby.) J. Sm. Forest clearings; rare.
Pteridium esculentum (Forst.) Cockayne. Common on lower levels.
Polypodium Billardieri (Willd.) C. Chr. Epiphytic on trees and rocks.
—— *diversifolium* Willd. Tree-trunks; not common.

Lycopodiaceae.

Lycopodium Billardieri Spring. On trees; rare.
—— *ramulosum* T. Kirk. Forest; rare.
—— *fastigiatum* R. Br. Alpine scrub; rare.
—— *scariosum* Forst. f. Forest track.
—— *volubile* Forst. f. Alpine scrub; rare.

Spermophyta.

Taxaceae.

Podocarpus Hallii T. Kirk. Rare in forest.
—— *nivalis* Hook. f. Abundant, subalpine scrub.
Dacrydium laxifolium Hook. f. Rare.
Phyllocladus alpinus Hook. f. Common.

Gramineae.

Danthonia Cunninghamii Hook. f. Common in forest.
—— *flavescens* Hook. f. Subalpine meadow.
—— *crassiuscula* T. Kirk. Subalpine meadow.
Poa caespitosa Forst f. Subalpine meadow.
Agropyron scabrum (R. Br.) Beauv. Upper Routeburn Flat; common.

Cyperaceae.

Oreobolus pectinatus Hook. f. Subalpine; in bogs.
—— *pumilio* R. Br. Mountains above Lake Harris; reported by T. Kirk.
Uncinia tenella R. Br. Routeburn.
Carex lucida Boott. In forest.
—— *acicularis* Boott. Mountains, Lake Harris; reported by T. Kirk.

Juncaceae.

Luzula campestris D.C. Common in subalpine meadow.

Liliaceae.

Luzuriaga marginata (Banks & Sol.) Benth. & Hook. In forest ; rare.
Astelia linearis Hook. f. Common ; Lake Harris.
—— *nervosa* Banks & Sol. Common in forest.
—— *montana* (Kirk) Cockayne. Common ; subalpine scrub.
—— *Petriei* Cockayne. Lake Harris ; reported by Cockayne.
Phormium Cookianum Le Jolis. Not common.
Bulbinella Hookeri Benth. & Hook. f. Abundant ; subalpine meadow.
Herpolirion novae-zealandiae Hook. f. Subalpine ; rare.

Orchidaceae.

Thelymitra uniflora Hook. f. Subalpine bog.
Gastrodia Cunninghamii Hook. f. Beech forest.

Fagaceae.

Nothofagus fusca (Hook. f.) Oerst. Forest.
—— *Menziesii* (Hook. f.) Oerst. Forest.
—— *Solandri* (Hook. f.) Oerst. Forest.
—— *cliffortioides* (Hook. f.) Oerst. Forest.

Urticaceae.

Urtica incisa Poir. In forest ; not common.

Loranthaceae.

Elytranthe Colensoi Engl. On *Nothofagus ;* common near mouth of Routeburn.

Polygonaceae.

Rumex flexuosus Sol. Routeburn Flat ; common.
Muehlenbeckia complexa (A. Cunn.) Meissn. In forest.
—— *axillaris* Walp. Common, Routeburn Flat.

Portulacaceae.

Claytonia australasica Hook. f. Abundant near Lake Harris.

Caryophyllaceae.

Stellaria parviflora Banks & Sol. Subalpine meadow.

Ranunculaceae.

Ranunculus Buchanani T. Kirk. Rocks, Upper Routeburn (Speden).
—— *Lyallii* Hook. f. Abundant above bush-line.
—— *gracilipes* Hook. f. Sulbapine bogs.
—— *hirtus* Banks & Sol. Abundant in forest.
—— *rivularis* Banks & Sol. Not common.
—— *lappaceus* Sm. Abundant throughout.
—— *sericophyllus* Hook. f. Near Lake Harris Saddle.
—— *foliosus* T. Kirk. Subalpine swamps ; rare.
—— *Enysii* T. Kirk. Lake Harris ; reported by T. Kirk.
Caltha novae-zealandiae Hook. f. Lake Harris ; reported by T. Kirk.

Magnoliaceae.

Drimys colorata Raoul. Not common.

Cruciferae.

Cardamine heterophylla (Forst. f.) Schultz. Abundant.

Droseraceae.

Drosera Arcturi Hook. Bog, Lake Harris.

Saxifragaceae.

Carpodetus serratus Forst. Somewhat rare.

Pittosporaceae.

Pittosporum tenuifolium Banks & Sol. Routeburn Valley.

Rosaceae.

Rubus australis Forst. f. Routeburn Valley.
—— *cissoides* A. Cunn. Forest, Routeburn Valley.
Geum parviflorum Smith. Abundant above 2,000 ft.
—— *uniflorum* Buch. Lake Harris Saddle.
Potentilla anserina L. var. *anserinoides* (Raoul) T. Kirk. Rare.
Acaena Sanguisorbae Vahl. Common.
—— *novae-zealandiae* Kirk. Common.
—— *microphylla* Hook. f. Common.
—— *glabra* Buchanan. Mountains above Lake Harris; reported by T. Kirk.

Geraniaceae.

Geranium microphyllum Hook. f. Common at all heights.
—— *sessiliflorum* Cav. Routeburn Flat and Lake Harris.
Oxalis magellanica Forst. Abundant, subalpine meadow.

Coriariaceae.

Coriaria thymifolia Humb. & Bonpl. Common.
—— *angustissima* Hook. f. Common.

Leguminosae.

Sophora tetraptera J. Mull. Routeburn Valley.
Carmichaelia grandiflora Hook. f. Common, creek-sides, Routeburn Flat.

Elaeocarpaceae.

Aristotelia fruticosa Hook. f. Common, creek-banks, in forest.

Malvaceae.

Plagianthus betulinus A. Cunn. Lower Routeburn.
Gaya Lyallii Baker. Common in forest.

Violaceae.

Viola Cunninghamii Hook. f. Plentiful at all levels.

Thymelaeaceae.

Pimelia laevigata Gaertn. Upper Routeburn.
Drapetes Dieffenbachii Hook. Upper Routeburn.

Myrtaceae.

Leptospermum scoparium Forst. Lower Routeburn.

Onagraceae.

Epilobium pubens A. Rich. Routeburn Flat.
—— *rotundifolium* Forst. Routeburn Flat.
—— *linnaeoides* Hook. f. Routeburn Flat.
—— *pycnostachyum* Haussk. Shingle-beds, Routeburn Flat.
—— *melanocaulon* Hook. Shingle-beds, Routeburn Flat.
—— *chloraefolium* Haussk. Not common.
Fuchisa excorticata Linn. f. Damp; uncommon.

Araliaceae.

Nothopanax simplex (Forst.) Seem. Forest; rare.
—— *Edgerleyi* (Hook. f.) Seem. Forest.
—— *Colensoi* (Hook. f.) Seem. Forest; not common.
Pseudopanax crassifolium (Sol.) C. Koch. Not uncommon.

Umbelliferae.

Hydrocotyle novae-zealandiae D.C. Plentiful, Upper Routeburn.
Aciphylla Colensoi Hook. f. Common.
—— *Lyallii* Hook. f. Common, Upper Routeburn.
—— *Monroi* Hook. f. Lake Harris Saddle; rare.
Anisotome Haastii Kirk. Upper Routeburn Flat.
—— *brevistyle* Kirk. Upper Routeburn Flat; common.
Angelica Gingidium Hook. f. Common.

Cornaceae.

Griselinia littoralis Raoul. Lower Routeburn; not plentiful.

Ericaceae.

Gaultheria antipoda Forst. var. *erecta* Cheeseman. Not common; in forest clearings.
—— *rupestris* R. Br. Upper Routeburn; common.

Epacridaceae.

Pentachondra pumila (Forst. f.) R. Br. Subalpine heath.
Styphelia Fraseri (A. Cunn.) F. Muell. Subalpine heath.
Archeria Traversii Hook. f. var. *australis* T. Kirk. Forest; rare.
Dracophyllum uniflorum Hook. f. Upper Routeburn.
—— *Traversii* Hook. f. Not uncommon.
—— *Menziesii* Hook. f. Mountains above Lake Harris; reported by T. Kirk.
—— *prostratum* T. Kirk. Mountains above Lake Harris; reported by T. Kirk.

Myrsinaceae.

Suttonia divaricata (A. Cunn.) Hook. f. Lower Routeburn.
—— *nummularia* Hook. f. Subalpine heath.

Gentianaceae.

Gentiana Grisebachii Hook. f. Lake Harris Saddle.

Apocynaceae.

Parsonsia heterophylla A. Cunn. Lower Routeburn.

Boraginaceae.

Myosotis macrantha Hook. f. Routeburn Flat.

Labiatae.

Mentha Cunninghamii Benth. Not uncommon.

Scrophularinaceae.

Veronica salicifolia Forst. Creek-bank, forest.
—— *buxifolia* Benth. Common in alpine scrub.
—— *subalpina* Cockayne. Common in alpine scrub.
—— *monticola* Armstr. Common in alpine scrub.
—— *linifolia* Hook. f. Shady situations, Lake Harris track.
—— *leiophylla* Cheeseman. In forest ; rare.
—— *Lyallii* Hook. f. Abundant.
—— *Hectori* Hook. f. Subalpine heath.
—— *macrantha* Hook. f. Lake Harris Saddle.
—— *glaucophylla* Cockayne. Subalpine heath.
—— *Wilcoxi* Petrie. Upper Routeburn.
—— *Petriei* (Buch.) T. Kirk. Lake Harris Saddle ; reported by Wilcox and Cockayne.
Ourisia macrophylla Hook. f. Upper Routeburn ; common.
—— *sessilifolia* Hook. f. Lake Harris ; common.
—— *caespitosa* Hook. f. Damp places, subalpine.
—— *prorepens* Petrie. Not common.
—— *Cockayniana* Petrie. Lake Harris.
Euphrasia zealandica Wettst. Subalpine bog.
—— *Dyeri* Wettst. Subalpine bog.

Plantaginaceae.

Plantago Brownii Rapin. Subalpine ; common.

Rubiaceae.

Coprosma lucida Forst. Damp forest.
—— *parviflora* Hook. f. Forest ; common.
—— *acerosa* A. Cunn. var. *brunnea* Kirk. Forest.
—— *foetidissima* Forst. Shady forest.
—— *cuneata* Hook. f. Subalpine heath.
—— *repens* Hook. f. Upper Routeburn.
—— *Petriei* Cheeseman. Upper Routeburn.
—— *serrulata* Hook. f. Subalpine scrub.
Nertera dichondraefolia (A. Cunn.) Hook. f. Damp logs.
Galium umbrosum Sol. Routeburn Flat.

Campanulaceae.

Pratia angulata (Forst. f.) Hook. f. Common throughout.
Wahlenbergia saxicola (R. Br.) A. D.C. Common throughout.

Stylidiaceae.

Phyllachne clavigera (Hook. f.) F. Muell. Subalpine bogs.
Oreostylidium subulatum (Hook. f.) Berggr. Subalpine bogs.
Forstera sedifolia Linn. f. Lake Harris Saddle, Upper Routeburn; abundant.
—— —— var. *occulata* Linn. f. Lake Harris Saddle, Upper Routeburn; abundant.

Compositae.

Lagenophora pumila Forst. f. Not common.
—— *petiolata* Hook. f. Common in forest.
Brachycome Sinclairii Hook. f. Subalpine scrub.
Olearia nitida Hook. f. Common in forest.
—— *virgata* Hook. f. var. *lineata* Kirk. Creek-bank.
—— *moschata* Hook. f. Abundant, subalpine scrub.
—— *nummularifolia* Hook. f. Upper Routeburn.
Celmisia longifolia Cass. Common throughout.
—— *sessiliflora* Hook. f. Abundant, Lake Harris.
—— *bellidioides* Hook. f. Rare; near creek, 2,700 ft.
—— *verbascifolia* Hook. f. Common, Upper Routeburn.
—— *Petriei* Cheeseman. Abundant, Upper Routeburn.
—— *discolor* Hook. f. Not common, Upper Routeburn.
—— *densiflora* Hook. f. Rare.
—— *incana* Hook. f. Tolerably plentiful.
—— *Haastii* (?) Hook. f. Lake Harris; fairly plentiful; perhaps a new species.
—— *laricifolia* Hook. f. Harris Saddle; common.
—— *linearis* Armstr. Ocean Peak.
—— *petiolata* Hook. f. Not common.
—— *spectabilis* Hook. f. Upper Routeburn.
—— *ramulosa* Hook. f. Ocean Peak.
—— *glandulosa* Hook. f. Common, Lake Harris.
—— *Walkeri* T. Kirk. Abundant, Harris Saddle.
—— *Sinclairii* Hook. f. Not common.
—— *Lindsayi* Hook. f. (?). Lake Harris; reported by H. J. Matthews.
Gnaphalium luteo-album Linn. Routeburn Flat.
Raoulia grandiflora Hook. f. Lake Harris.
—— *australis* Hook. f. Shingle-bed, Routeburn Flat.
—— *glabra* Hook. f. Shingly bed, Routeburn Flat.
—— *lutescens* Hook. f. Upper Routeburn; on rocks.
—— *Buchanani* T. Kirk. Lake Harris.
Helichrysum bellidioides (Forst. f.) Willd. Common.
—— *grandiceps* Hook. f. Rocks, Upper Routeburn.
—— *filicaule* Hook. f. Common.
Cassinia Vauvilliersii Hook. f. Upper Routeburn.
Craspedia uniflora Forst. f. var. *robusta* Hook. f. In forest.
Cotula dioica Hook. f. Common, Routeburn Flat.
—— *squalida* Hook. f. Routeburn Flat.
Senecio bellidioides Hook. f. Lake Harris; rare.
—— *Lyallii* Hook. f. Abundant, Upper Routeburn.
—— *scorzoneroides* Hook. f. Abundant, Upper Routeburn.
—— *lautus* Forst. f. Routeburn Flat.
—— *elaeagnifolius* Hook. f. In forest; rare.
—— *revolutus* T. Kirk. Not common.
Microseris Forsteri Hook. f. Routeburn Flat.

Art. VI.—*Some Additions to the Flora of the Westport District.*

By D. Petrie, M.A., Ph.D.

[*Read before the Auckland Institute, 3rd December, 1913.*]

Mr. Townson's fruitful investigation of the vegetation of the neighbourhood of Westport has made botanists well acquainted with the phanerogamic flora of this very interesting district. Early in the present year I paid a visit of a few weeks to the scene of Mr. Townson's labours, and largely through the kindness of Mr. P. G. Morgan, Director of the Dominion Geological Survey, was able to examine a number of interesting localities not usually easy of access.

The additional species that I noted do not form an extensive list, as very few of the plants native to the district escaped Mr. Townson's vigilant search. One or two of fairly common occurrence have probably escaped record by accident in handling so large a collection as he got together.

Two or three of the species in his list appear to me to have been incorrectly identified. The *Senecio* so common near Cape Foulwind I should without hesitation refer to *S. elaeagnifolius* Hook. f., and not to *S. rotundifolius* Hook. f. I examined a great many specimens of this shrub, and found that the leaves, though more coriaceous than usual, are nearly always longer than broad, in outline more or less ovate or ovate-oblong, and not rarely waved or repandly toothed at the margin. At an elevation of 2,300 ft. or so on the Longwood Range, Southland, specimens of *S. elaeagnifolius* may be seen in the forest with leaves approaching those of *S. rotundifolius* much more closely than do any to be found near Cape Foulwind. The occurrence of *S. elaeagnifolius* close to sea-level at Cape Foulwind is not as surprising as might at first sight appear, since the vegetation of the lowland water-logged pakihis near Westport is mainly that of subalpine moors.

The grass referred to *Agrostis parviflora* R. Br. seems to me the ordinary small-flowered form of *A. Dyeri*, that grows in some plenty on all the open lowland and submontane districts around Westport. As this grass was collected at an elevation of 3,000 ft. on Mount Rochfort, it is on that ground alone unlikely to be *A. parviflora*, which is not known to reach elevated habitats.

The *Raoulia* that grows sparingly near the top of Mount Rochfort, and in great abundance on the shingly spurs near the tops of the Buckland Peaks, is certainly not *R. mammillaris* Hook. f., as Mr. Townson's list has it, but is in all likelihood a form of *R. eximia* Hook. f. with more truncate leaves and barer leaf-tips than that species usually shows.

The *Celmisia coriacea* Hook. f. of Mr. Townson's list I am describing elsewhere in this volume (p. 33) as a new species. It occurs near sea-level at Charleston, where it is most variable in size, and is the commonest *Celmisia* above the bush-line on the Buckland Peaks. It seems doubtful if *C. coriacea* occurs on the mountains flanking the West Coast in the Buller district.

The list of additions is as follows :—

Hoheria populnea A. Cunn. var. **vulgaris** Hook. f. Buller Gorge, near Inangahua Junction, and Mokihinui River, near the mouth.

Tillaea Sinclairii Hook. f. Damp hollows in sandhills north of Westport Harbour.

Metrosideros Colensoi Hook. f. Limestone cliffs near Little Totara River, and Mokihinui River, near the mouth.

Hydrocotyle tripartita R. Br. Sand-banks of Mokihinui River, near the mouth.

Panax anomalum Hook. On edge of bush at Mount Rochfort, and near Addison's Flat.

Coprosma tenuicaulis Hook. f. Common on wet alluvial flats near Westport, and in similar positions throughout the district.

Olearia capillaris Buchanan. Sources of Nile River, Western Paparoas; J. A. Bartrum!

Celmisia Morgani Cheeseman sp. nov. (*ante*, p. 21). Shaded slopes in bush near mouth of Ngakawau River, Blackwater River, and Buller Gorge near the same.

Celmisia semicordata sp. nov. (*post*, p. 33). Charleston, near sea-level; common above the bush-line on the Buckland Peaks.

Raoulia eximia Hook. f. Top of Mount Rochfort; common on shingly slopes of Buckland Peaks, at 3,000–4,000 ft.

Phyllachne Colensoi Bergg. Wet spots on the higher parts of the Buckland Peaks.

Gentiana vernicosa Cheeseman, var. Mr. Townson referred this plant to *G. Townsoni* Cheeseman. It seems much nearer to *G. vernicosa*, though my specimens are seldom branched and hardly match the typical form, which Mr. Cheeseman has kindly lent me for comparison. *G. Townsoni* may not occur at all on the Buckland Peaks, and is, in any case, very rare there.

Calystegia tuguriorum R. Br. Common on alluvial flats near Westport.

Limosella tenuifolia Nutt. Wet hollows in the sandhills north of Westport Harbour.

Veronica angustifolia A. Rich. Buller Gorge, not far from Inangahua Junction.

Pimelea Urvilleana A. Rich. Coast cliffs at Charleston.

Dacrydium laxifolium Hook. Buckland Peaks, above the bush-line; not rare.

Juncus pauciflorus R. Br. Wet peaty spots at Cape Foulwind.

Scirpus nodosus Rottb. Sandhills at Rahui, near Charleston.

Schoenus nitens Poir. North branch of Westport Harbour.

Carex subdola Boott. Fairly common in swampy open stations about Westport.

Carex uncifolia Cheeseman. Wet ridges near tops of Buckland Peaks. The specimens were in poor condition, but they no doubt belong here.

Carex Buchanani Bergg. Buller Flats, south of the staiths, Westport.

Carex Gibbsii sp. nov. Open swampy flats at Cedar Creek (near Denniston), 1,760 ft.

Art. VII.—*Descriptions of New Native Phanerogams.*

By D. Petrie, M.A., Ph.D.

[*Read before the Auckland Institute, 3rd December, 1913.*]

1. Ranunculus Grahami sp. nov.

Folia radicalia pauca, coriacea, ± 10 cm. longa ; petiolis 6–7 cm. longis, crassiusculis, subcomplanatis, inferne vaginantibus ; laminis semi-orbicularibus, 5 cm. latis, in segmenta tria late cuneata partitis, segmentis in lobos 3–5 breves rotundatos sectis. Folia caulina 1–2, subdistantia, radicalibus similia sed minora breviusque petiolata.

Scapi foliis longiores, petiolis graciliores, in fructu ± 15 cm. longi, glabri, 1-flores (1–4-flores ?).

Flores majusculi, ± 1½ cm. lati ; sepala 5, obtusa, plurinervata, extra parce subpilosa ; petala 10, sepalis longiora, 1½ cm. longa, anguste cuneata, obtusa ; stamina 1–2-seriata ; carpella plurima ; achenia turgida, breviter 2-alata, rostro longo curvato.

Rootstock rather stout, descending, giving off numerous fleshy lateral roots.

Radical leaves few, coriaceous, ± 10 cm. long ; petioles 6–7 cm. long, rather stout, glabrous, more or less flattened and expanded below into a broad sheath bearing sparse silky hairs at its mouth ; blades semiorbicular in outline, broader than long, deeply parted into 3 broadly cuneate segments that are cut into 3–5 short rounded lobes, glabrous but for a few delicate silky hairs on the margin and upper part of the back, nerves obscure, reticulate, veining evident. Cauline leaves 1–2, rather distant, similar to the radical, but smaller and with shorter petioles.

Scapes more slender than the petioles, exceeding the leaves, in fruit ± 15 cm. long, glabrous, 1-flowered (in my specimens).

Flowers rather large, ± 1½ cm. across. Sepals 5, broadly ovate, obtuse, membranous, yellowish, many-nerved, sparsely covered outside with delicate white silky hairs ; petals 10, longer than the sepals, 1½ cm. long, narrow-cuneate, obtuse, yellow, bearing a single nectary near the base ; stamens in 1 or 2 series, with rather long flattened filaments ; carpels very numerous ; achenes turgid, shortly 2-winged with a long curved beak and a few delicate silky hairs chiefly on the wings.

Hab.—Rocks of "Aiguille Roque," a peak south of Malte Brun, Mount Cook district, 9,000 ft. ; Coronet Peak, Mount Cook district.

Mr. Peter Graham, chief guide at the Hermitage, collected this plant, which is named in his honour. He writes me that the scapes frequently bear 3 or 4 flowers. The plant seems more nearly related to *R. pinguis* Hook. f. than to any of the mainland species.

2. Epilobium antipodum sp. nov.

Epilobium E. confertifolio Hook. f. affine ; differt foliis majoribus, elliptico-obovatis, in petiolos latiusculos paene aequilongos attenuatis, capsulis robustioribus longioribusque.

Stems creeping and rooting at the nodes, leafy, moderately stout, glabrous.

Leaves in opposite pairs, connate at the base, close-set and often overlapping, $2\frac{1}{2}$–$3\frac{1}{2}$ cm. long, 1–$1\frac{1}{4}$ cm. broad, narrow elliptic-obovate, obtuse, contracted into rather broad flat petioles nearly as long as the blades, semi-membranous, glabrous, delicately repando-denticulate above the middle, reddish at the edges; veins evident, diverging from the conspicuous midrib.

Peduncles short, elongating in fruit, slender, near the tips of the branches; calyx-lobes lanceolate-subulate, acute, nearly equalling the rather broad slightly notched pale-red petals.

Capsules glabrous, rather stout, ± 5 cm. long, when mature on slender erect peduncles about as long as the capsules; seeds obovate, $1\frac{1}{3}$ mm. long, delicately papillose.

Hab.—Antipodes Island. B. C. Aston!

The above description has been drawn up from specimens grown in my garden, and raised from seed obtained from dried capsules kindly sent me by Mr. Aston, whose specimens were all past flower.

3. Celmisia semicordata sp. nov.

Celmisia C. coriaceae Hook. f. affinis; differt foliis subcordatis, supra pellicula delicatissima argenteo-cinerea levi vestitis; scapis gracilioribus brevioribusque; capitulis minoribus; petalis brevioribus glaberrimisque; acheniis glabris.

Leaves 15–30 cm. long, 3–5 cm. broad, oblong-lanceolate, acute or subacute, semicordate at the base, coriaceous, quite entire, with evident midrib but otherwise nerveless; above more or less furrowed longitudinally when dried, and covered with a very delicate smooth silvery or greenish-grey pellicle; below flat, more or less recurved at the edges, clothed with dense smooth closely appressed white silky tomentum; sheaths about $\frac{1}{3}$ as long as the blades, thin, striate, narrowed above, more or less clothed with white cottony tomentum.

Scapes 30–40 cm. long, slender covered with loosely appressed cottony pubescence, scarcely tomentose; bracts erect, narrow-linear, becoming shorter upwards.

Heads $2\frac{1}{2}$–4 cm. across, few to each tuft; involucral bracts in 2–3 series, glabrate or the outer slightly cottony, linear-subulate, brown, thickened below; petals numerous, spreading, narrow, $1\frac{3}{4}$ cm. long; tube of corolla narrow and quite glabrous.

Achene 5 mm. long, glabrous, linear, ribbed, slightly compressed; pappus equalling or slightly exceeding the achene.

Hab.—Buckland Peaks (near Westport), 3,300–4,000 ft.; Charleston, 30–40 ft.

The Charleston specimens have much shorter and more slender scapes and smaller flower-heads than usual, while their subacute leaves exhibit remarkable variation in size, being often less than half as long as in the typical mountain form, which shows very little variation. The plant is plentiful above the bush-line on the Buckland Peaks, and at higher levels is associated with *C. Armstrongii* and *C. Dallii.*

4. **Wahlenbergia Morgani** sp. nov.

Wahlenbergia W. saxicolae A. D.C. affinis; differt foliis laxioribus minoribus tenuioribus, ± spathulatis, pedunculis brevibus, floribus multo brevioribus, capsula breviore globosa.

A depressed tufted almost glabrous perennial, more or less branched from the root, and often intricately so, when it forms matted patches 8–12 cm. across. Branches up to 8 cm. long but usually much shorter, when elongated diffuse and several times subdivided, slender, leafy towards the tips and occasionally sparsely villous; older bark pale, soft and spongy.

Leaves rather close set or (in matted forms) crowded, $1\frac{1}{4}$–2 cm. long, very variable in outline, orbicular- or obovate- or elliptic-spathulate, membranous or nearly so, more or less crenate-dentate, blades glabrous, midrib obscure when mature otherwise nerveless; the narrow petiolar part thin, considerably longer than the blade, and more or less ciliate along the edges.

Flowering-stems bearing 1–2 (or rarely 3) shortly peduncled lateral or terminal flowers; peduncles slender, terete, smooth, elongating in fruit to $1\frac{1}{2}$–4 cm.

Flowers campanulate, about 8 mm. long and 6 mm. across, pale blue. Calyx glabrous, shortly turbinate; lobes broadly subulate, erect, acute or subacute; corolla cut for rather more than $\frac{1}{3}$ its length into 5 subacute scarcely spreading lobes; style expanded towards the top and rather deeply divided into flat lamellar plates.

Capsule globose, 5–6 mm. long, when ripe marked by blunt tubercles, 2-celled; seeds minute, very numerous, slightly plano-convex in section. (*W. saxicola* A. D.C. var. *congesta* Cheeseman.)

Hab. — Cape Farewell; W. Townson! Road-cuttings near Rahui (Charleston); moist sandhills near Fortrose (Southland).

The Fortrose specimens grew in pure sand, and have narrower more coriaceous and more strongly toothed leaves than the typical plant from south-west Nelson. The species is not confined to sandy situations, for at Rahui it flourishes in great profusion on nearly vertical faces of hard conglomerate rock. It is named in compliment of Mr. P. G. Morgan, M.A., Director of the Dominion Geological Survey, from whom I have received much valuable help in studying the plants of the Buller district.

5. **Myosotis suavis** sp. nov.

Perennis; ubique pilis albidis subrigidis dense hispida.

Caules pauci, graciles, ad 10 cm. alti.

Folia radicalia late obovato-spathulata, 3–4 cm. longa, $1\frac{1}{2}$ cm. lata, subacuta, tenuia; caulina numerosa, late lanceolata, acuta, sessilia.

Flores brevissime pedunculati, ± 1 cm. longi, calyx corolla subduplo brevior, 5-partitus, lobis subulatis; corolla infundibuliformis, alba, dulce odorata, limbo in lobos 5 breves rotundatos secto; stamina corollae tubum haud excedentia, brevia, parva, paene sessilia.

A low tufted perennial, everywhere densely hispid with short stiff white hairs.

Flowering-stems few, erect or ascending, slender, leafy, 10 cm. high or less.

Radical leaves few, broadly obovate-spathulate, 3–4 cm. long, $1\frac{1}{2}$ cm. broad, subacute, thin, midrib evident; cauline numerous, usually closely placed, broadly lanceolate, acute, sessile.

Racemes rarely branched; flowers crowded, very shortly pedicellate, ± 1 cm. long, strongly and sweetly scented; calyx half as long as the corolla, 5-lobed to the middle, lobes subulate; corolla funnel-shaped, white, tube narrow; scales of the throat 5, limb cut into 5 short rounded spreading lobes; stamens reaching to the top of the corolla-tube; anthers short, small, almost sessile; style slender, subcapitate, when full-grown a little longer than the corolla-tube.

Hab.—Slopes of Mount Sefton, between the Stocking and Huddleston Glaciers, 5,000 ft.; a high peak north of Stewart Glacier, Moorhouse Range (Mount Cook district). Flowers in February.

Specimens of this plant have been kindly sent me by Mr. Peter Graham, chief guide at the Hermitage. In recent years his careful observation has brought to light quite a number of new alpines that hail from places difficult of access to those who are not expert mountaineers.

6. **Carex Gibbsii** sp. nov.

Species *C. Dallii* T. Kirk affinis.

Folia culmis multo breviora, omnino radicalia. Culmi gracillimi ± 50 cm. longi, teretes, reclinati.

Inflorescentia terminalis, 4 cm. longa breviorve; spiculae 3–4, arcte approximatae, sessiles, brevissimae; terminali mascula, ceteris femineis; bracteis foliis similibus, brevibus inflorescentiam tamen excedentibus; glumae ovatae, subacutae, breviter mucronatae, utriculis maturis paulo breviores.

Utriculi anguste ovati, sub-plano-convexi, glaberrimi, 3 mm. longi, 1½ mm. lati, rostro bidentato valde brevi.

A slender laxly tufted reddish-green plant, giving off rather long stolons clothed with short reddish-brown striate scales.

Culms very slender, leafy only at the base, 50 cm. long or less, terete, smooth, slightly grooved, reclinate, reddish-brown.

Leaves much shorter than the culms (± 10 cm. long), spreading, shortly sheathing, narrow-linear, concave when fresh, complicate when dried, flaccid, striate below, 2-nerved above, midrib little conspicuous.

Inflorescence 4 cm. long or less; spikelets 3–4, closely approximate, sessile, very short, dark reddish-brown; terminal male, slender, the others female; bracts short and leaf-like, but exceeding the flowering-spike; glumes ovate, membranous, reddish-brown, subacute, 3-nerved, the nerves confluent at the top and produced into a short mucro, slightly shorter than the mature utricles.

Utricles narrow-ovate, nearly plano-convex, nerveless or with 2 indistinct lateral nerves, substipitate, yellowish below, purplish above, 3 mm. long, 1½ mm. broad; beak very short, 2-toothed; style deeply divided into 3 stigmatic branches.

Hab.—Shallow open swampy flats at Cedar Creek, Waimangaroa River (near Denniston), west Nelson, about 1,760 ft.

This species differs from *C. Dallii* T. Kirk in the short inflorescence with closely approximate small spikelets, the almost plano-convex utricles, and the much longer, almost filiform, culms. The plants grew in perfectly open ground, but only a few were in flower. It is named in honour of Mr. F. G. Gibbs, of Nelson, who has done much excellent work in exploring the flora of that district, and has been a most obliging and helpful correspondent.

7. **Deyeuxia glabra** sp. nov.

Gramen *D. Forsteri* Kunth var. *littoralis* Hackel affine.

Spiculae parvae, pallide virides, 3–3½ mm. longae; glumae floriferae vacuis dimidio breviores, ovatae, apice ± truncatae ac erosae, glaberrimae, membranaceae, hyalinae, leviter 3-nervatae, nervis lateralibus vix excurrentibus, nervo medio in aristam terminalem persubtilem rectam vel curvatam raro extra glumam exsertam producto; glumae basi glaberrima; rachilla brevi gracili parce pilosa.

A slender laxly tufted grass, branching from the base.

Culms up to 30 cm. high, very slender, sparingly leafy. Leaves distant on the culms, the lower short, the upper longer; sheaths long, the uppermost reaching the base of the expanded panicle; blades flat, linear, smooth, thin, striate, gradually tapering to the tip, bright green; ligule long, membranous, coarsely toothed or cut at the top.

Panicle contracted in the young state, later lax and spreading, broadly ovate, 10 cm. long or less; branche in rather distant whorls of 4 or fewer, finely capillary, scaberulous, once or twice trichotomously divided, naked below, bearing few spikelets on long very delicate pedicels.

Spikelets small, 3–3½ mm. long, pale green; empty glumes equal, lanceolate, acute, membranous, obscurely 1-nerved, slightly ciliate on the upper part of the keel, scarious at the sides and top; flowering-glumes about half as long as the empty, ovate, more or less truncate and erose at the tip, perfectly glabrous, membranous and hyaline, faintly 3-nerved, the lateral nerves barely excurrent, the median produced into a delicate straight or bent terminal awn rarely exserted beyond the empty glumes, the base of the glume destitute of hairs; palea highly membranous, narrow, as long as the flowering-glume, its nerves obscure and glabrous; rhachilla short, slender, sparingly pilose.

Hab.—Moist grounds by the seaside at Bluff and Fortrose, Southland.

This plant can be readily distinguished from *D. Forsteri* by the glabrous flowering-glumes, the short delicate terminal awn, and the absence of a tuft of hairs at the base of the flowering-glume.

8. **Danthonia teretifolia** sp. nov.

Gramen *D. ovatae* Buchanan affine; differt foliis gracilibus, firmis, teretibus, pilis subrigidis appressis ± dense vestitis, in apices elongatos filiformes undulatos attenuatis; paniculi ramis infimis 3-verticillatis; dentibus glumae floriferae lateralibus scariosis in aristas ciliatas gradatim attenuatis; et arista media subtus complanata ac contorta.

A densely tufted grass, forming large compact yellowish-green tussocks.

Culms 30–50 cm. long, exceeding the leaves, slender, terete, glabrous, slightly grooved, yellowish, invested by 2 distant long-sheathing cauline leaves not exceeding the panicle.

Leaves few on each culm, slender, involute, terete, wiry, pale yellowish-green, the sides and inner face densely pilose with stiff appressed hairs, the margins thickened and glabrous, the keel rounded and polished and sparingly pilose or almost glabrous, gradually narrowed into long filiform wavy tips; sheaths about ⅕ as long as the blades, broad and closed almost to the tops, coriaceous, striate, glabrous or nearly so, persistent; ligule a broad band of delicate hairs with longer tufts at the sides.

Panicle narrow-ovate, 6–10 cm. long; branches in whorls of 3 or fewer, sparingly subdivided, bearing few spikelets; rhachis glabrous.

Spikelets on long slender glabrous or sparsely pilose pedicels, large (10–13 mm. long without the awns), 5–6-flowered; empty glumes slightly unequal, $\frac{3}{4}$ the length of the spikelet, lanceolate, acute, glabrous, pale, membranous, 3–7-nerved below, the median nerve alone reaching to the top, nerves greenish, scarious at the edges, the upper part glabrous the lower part pilosely hairy at the base back and sides, deeply bifid at the top, the lateral teeth scarious and gradually narrowed into short ciliate awns; central awn from between the teeth, as long as the glume or longer, flattened and twisted below and ciliate along the edges; palea as long as the flowering-glume, strongly 2-nerved, the nerves pilosely ciliate and the incurved edges pilosely silky below.

Hab.—End Peak, Lake Hauroto, 4,000 ft.; J. Crosby Smith! Top of Longwood Range, Southland, 3,000 ft.

This grass differs from *D. ovata* in the character of the awns, the median one being conspicuously flattened and twisted at the base, and in the terete wiry almost filiform leaves clothed with appressed stiff hairs. The plate accompanying the description of Buchanan's species shows the leaves more or less flat, with spreading distant or sparse soft hairs. He lays special stress on the "straight subulate awns" and on the absence of twisting in the median one. The drawing, moreover, shows a series of distinct pencils of hairs on the flowering-glumes that is wholly alien to the present plant. No specimen of his grass is known to exist in any herbarium.

9. **Danthonia Buchanani** Hook. f. var. **tenuis** var. nov.

Folia setaceo-filiformia, culmis breviora. Panicula linearis, ± 3 cm. longa.

Spiculae quam in typo breviores angustioresque, 6 mm. longae.

Glumae floriferae annulo piloso medio inferiusque flocco pilorum brevi orum unico a latere utroque indutae, basi glabrae vel sparse pilosae; arista terminali setacea, brevi, recta; dentibus lateralibus acutis vel acuminatis, brevibus, in aristas haud productis.

Leaves filiform-setaceous, shorter than the culms.

Panicle linear, about 3 cm. long.

Spikelets shorter and narrower than in the type, 6 mm. long.

Flowering-glumes with a narrow band of stiff hairs across the middle of the back, and a single small tuft of shorter hairs lower down on each side; base and lower part of the glume glabrous or sparsely pilose.

Median awn setaceous, short, straight; lateral teeth short, acute or acuminate, not produced into awns.

Hab.—Swampy Hill (Dunedin), 1,500 ft.; Upper Waipori (Tuapeka County), 2,000 ft.; Mount Ida (Maniototo County), 3,000 ft.

In districts where it is abundant this variety forms an important element in the upland pastures of Otago.

10. **Danthonia semiannularis** R. Br. var. **nigricans** var. nov.

Gramen *D. semiannulari* R. Br. var. *setifolia* Hook. f. subsimile; differt spiculis multo brevioribus, flosculis minoribus, glumis vacuis atro-brunneis ac a marginibus late scarioso-pallidis, lobis glumarum floriferum lateralibus valde delicatulis scariosis in aristas haud productis, culmis folia multo superantibus.

Tufted, glabrous.

Radical leaves few; much shorter than the culms (usually $\frac{1}{3}$ their length), involute, setaceous, erect, wiry, subpungent at the tips; cauline 3 or 4 with long closed sheaths and short blades.

Culms slender, wiry, erect, considerably overtopping the highest cauline leaf.

Panicle short ($2\frac{1}{2}$–4 cm. long), narrow-ovate to broadly linear; branches approximate, solitary, immediately more or less subdivided; lateral pedicels very short.

Spikelets ± 7 mm. long; florets small; empty glumes nearly equal, considerably exceeding the florets, dark brown or black, edged with broad pale scarious margins.

Flowering-glumes membranous with a dense band of hairs a little below the terminal lobes and equalling the delicate scarious acuminate awnless lateral teeth, their lower part almost glabrous or rarely sparsely pilose with 3 short tufts of very short hairs close to the base; awn setaceous, slightly flattened below, erect or bent to one side, not twisted.

Hab.—Mount Hector (Tararua Range), 3,800 ft.; Lake Harris (Lake County), 3,000 ft.; pakihis near Waimangaroa, 1,700 ft.; south of Millerton, 1,700 ft.; Burnett's Face (Denniston), 1,800 ft.

For specimens from two of the localities in south-west Nelson I am indebted to Mr. Percy G. Morgan, M.A., Director of the Dominion Geological Survey.

11. **Poa Poppelwellii** sp. nov.

Gramen caespitosum, perenne, laete viride.

Culmi foliaque *P. litorosae* Cheeseman plerumque similia; ligula late oblonga, acuta, membranacea.

Panicula lineari-oblonga, 10–15 cm. longa; ramis brevibus in fasciculis alternis densis imbricatis dispositis.

Spiculae ± 10 mm. longae, 4 mm. latae, 5–6-florae; glumae vacuae inaequales, spicula dimidio breviores, lanceolatae, acutae, glabrae, 3-nervatae (inferiore minus distincte), virides, a marginibus late scariosae; glumae floriferae ovato-lanceolatae, acutae, obscure 5-nervatae, delicatule scaberulae, callo dorso marginibusque inferioribus pilis ± longis vestitae; palea glumis floriferis quarta parte brevior, apice bifida, nervis ciliatis; styli rami palea dimidio breviores, stamina etiam breviora paene sessilia.

A strongly tufted smooth and polished dark-green perennial grass.

Culms numerous, branching at the base, erect, quite glabrous, 60–70 cm. high, moderately stout, leafy to the base of the panicle.

Leaves equalling or exceeding the culms, with long broad membranous grooved sheaths, narrow-linear, convolute, terete, obscurely striate, narrowed into stiff acuminate subpungent points, the margins thickened; ligule broadly oblong, acute, membranous.

Panicle linear-oblong, 10–15 cm. long; branches short, in alternate dense imbricating fascicles; rhachis and branches smooth and glabrous.

Spikelets ± 10 mm. long, 4 mm. broad, lanceolate, narrowed above and below, 5-6 flowered, florets sessile; empty glumes unequal, barely half as long as the spikelet, narrow-lanceolate, acute, glabrous or slightly scabrid on the upper part of the keel, 3-nerved (the lower less distinctly), green with broad scarious margins; flowering-glumes ovate-lanceolate, acute or

almost acuminate, obscurely 5-nerved, delicately scaberulous, green with scarious margins; keel scabrid above, its lower half clothed with long silky hairs, the callus and lower edges clad with similar but shorter hairs; palea $\frac{3}{4}$ the length of the flowering-glume, bifid at the top, nerves ciliate; style branches half as long as the palea, stamens still shorter and almost sessile.

Hab.—Stewart Island (probably at Herekopere Island, off Half-moon Bay).

In the last volume of the "Transactions of the New Zealand Institute" I erroneously referred this grass to *Poa litorosa* Cheeseman. Though it closely resembles that species in habit and foliage, and is very readily mistaken for it on a hand and eye examination, the spikelets have a very different structure. The above description is founded on specimens grown in my garden from some live pieces kindly sent me by Mr. H. Guthrie-Smith. It is named in honour of Mr. D. L. Poppelwell, of Gore, whose botanical investigations in Southland and Stewart Island are well known.

ART. VIII.—*On the Occurrence of* Poa antipoda *Petrie on Herekopere Island.*

By D. PETRIE, M.A., Ph.D.

[*Read before the Auckland Institute, 3rd December, 1913.*]

AMONG some live grasses sent me from Stewart Island by Mr. H. Guthrie-Smith was a piece of *Poa antipoda.* On receipt some of the culms were in flower, and others flowered after the plant had been established in my garden. This is a form that differs from the type in having slightly larger spikelets and somewhat stiffer leaves. It has been recorded previously only from our subantarctic islands, having been collected on Antipodes Island by the late Mr. T. Kirk in 1890, on Campbell Island by Mr. W. R. Chambers, and on the Auckland Islands by Messrs. Aston and Tennant. This extension of its range to the main islands of New Zealand is a matter of considerable interest.

The small islands off Stewart Island have now furnished a number of southern plants not found elsewhere outside the subantarctic area, and it is highly desirable that these islands, and especially the Snares, should be carefully explored. The Government might well use their steamers to facilitate this important piece of work.

Art. IX.—*Notes on the Phanerogamic Flora of the Ruahine Mountain-chain, with a List of the Plants observed thereon.*

By B. C. Aston, F.I.C., F.C.S.

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

[Note.—Since this paper was read the author has made further visits to these mountains, and the information thereby acquired is, by permission of the Hon. Editor, allowed to be inserted while the paper is passing through the press. It may be as well to state that the author's knowledge of these mountains is derived from a week spent with Mr. J. S. Tennant, M.A., M.Sc., in the Kaimanawa Mountains (January, 1911); a three-days trip to Makaretu and Umutoi with Mr. Frank Hutchinson, jun. (Rissington), in April, 1913; a ten-days journey with Mr. Robert A. Wilson (Bulls) and Mr. Frank Hutchinson, jun., in January, 1914, when a crossing of the mountains was made from Wakarara to Waiouru over what is known as Colenso's Track; and a solitary ascent of Whariti, 3,020 ft., in March, 1914. The author's warmest thanks are due to his good comrades in these wanderings for their many kindnesses.]

The Ruahine Mountains being a north-easterly continuation of the Tararua Mountains, from which they are separated only by the Manawatu Gorge, the two ranges possessing many physical characters in common (altitude, aspect, rock, water-supply, temperature), it is not surprising that the plant covering of the Ruahine Mountains is extremely similar to that of the Tararua Mountains in the arrangement of the plants into formations and associations. It will be easier in a short paper such as this to point out the exceptions to this statement which have impressed the author during four brief visits (totalling twenty-one days) to these mountains, in the months of March, April, and January, than to attempt to describe the plant covering of the whole range in a manner which the importance of the subject merits.

Unfortunately, the foothills up to 2,000 ft. on the eastern side of the range have been to a large degree denuded of forest through farming operations, and a search among the remnants of forests which remain might reveal many facts worthy of record. In these foothills a species not found on the Tararuas is the beautiful *Angelica rosaefolia*, usually on river cliff-faces. On the river-flats a variety of *Sophora tetraptera* is seen, with numerous trunks springing from or below the ground, the branches having a drooping habit, and the leaves very large. *Coprosma tenuifolia* is an abundant underscrub of the forest up to 3,600 ft., but is not recorded from the Tararuas.

One of the most striking ecological facts is the absence of *Fagus Menziesii*, which constitutes by far the most abundant forest-tree above 2,000 ft. up to 4,000 ft. on the Tararua Mountains. It was not observed in the lower forest of the main Ruahine Range, but in the lower forest of the Kaimanawa Mountains, on the eastern side, it is present, ascending to 3,000 ft. It is recorded from Tongariro National Park by Cockayne, and from the higher Waimarino by E. Phillips Turner. On the higher forest of the Ruahine and Kaimanawa Mountains it is certainly replaced by *Fagus*

176°

Tongariro 6458
Te Mari 4680
Ruapehu
Ruapehu No 2
Paratetetonga 3000
Umuhakaiti
Motuoraka
4770
Te Rustakeikare
Ngaruroro R.
Tawhaketewhango
Whakinarumaru
Manukapu
Mangaio
Te Rotete
Kaimaiaha
Ruahinerua 2767
Motu-iba
Orumaho
Karaitiaha
Kairakeho 3624
Tuhirangi 3149
Tapuae 2250
Rangitara 2258
MATAROA
TAIHAPE
Egmont Pk 2768
UTIKO
Pikiariria 2357
Rangi
Tahuaroongatea
Kawhatau No 2
Wharauhuru
RANGIWAHIA
HUNTERVILLE
APITI
Coal Cr.
DUMUTOI
KARAPI
BLACKBURN
Tokaroro Stn.
KARIOI
TURANGAREREO
MOAWANGO
Miles.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Authors track shewn thus
Colenso's ,, ,, ,,
Compiled from Survey Office Records, by J. G. K. 13/2/14
Authors Camps thus

176°

cliffortioides forest, which persists on the Mokai–Patea Ridge up to 4,000 ft. The extensive associations of the huge fern *Dicksonia lanata* recall those of Mount Hauhungatahi, both in the open at 2,000 ft., growing like a *Pteris*, as Colenso puts it, and under *Fagus* forest up to 3,700 ft. The almost impenetrable subalpine scrub which occurs on the Tararuas on many exposed ridges is absent from the Ruahine Range, although the individual species of the scrub association are usually present, with the remarkable exceptions of *Olearia excorticata* and *O. lacunosa*. The abrupt transition from forest to tussock meadow or herb-field would seem to be usual where *Fagus cliffortioides* is the forest, examples being common on the volcanic plateau.

Cordyline indivisa occurs in greater abundance on the Ruahine than on the Tararua Range. In portions of the beech forest, beds of *Astelia Cunninghamii* are a feature of the forest floor at about 2,000 ft.

Coming to the area above the forest, the entire absence of *Ligusticum dissectum*, perhaps the most abundant plant of the Tararuas above 4,000 ft., is striking. Two abundant plants of the Ruahine tops are *Celmisia incana* and *Dracophyllum recurvum*, neither of which occurs on the Tararua Range to any extent. *C. incana* is recorded thence only on the authority of Buchanan, and *D. recurvum* not at all. *Dracophyllum subulatum* also occurs. *Celmisia incana* would appear to fill the place which *C. hieracifolia* occupies on the Tararua Mountains. This species has not been recorded from the Ruahines, although an abundant alpine plant on the Tararuas.

On the Mokai–Patea Ridge the abundance of species of *Celmisia* (*C. spectabilis* and *C. incana*) in the tussock meadow is one of the floral sights of the North Island. The mountain-side is conspicuously white with the flowers of these two species when seen from a distance of five miles.

Other plentiful non-Tararuan constituents of the subalpine flora of the western side are *Epacris alpina* and *Dacrydium laxifolium*, while a rarer constituent is *Brachycome odorata*. The immense *Astelia nervosa* beds of the Tararuas are not to be found on the Ruahine Range, although the species frequently occurs in the subalpine zone. Something, however, very like the *Astelia* beds is furnished by the *Phormium* beds of the Mokai–Patea Ridge, eastern face, at 3,000 ft. elevation. Just below here, at 2,700 ft., some of the shrubby constituents of the lower forest flourish in a marvellous manner. Trees 20 ft. to 30 ft. high, with trunks 1 ft. to 3 ft. in diameter, of *Hoheria populnea* var. *lanceolata*, *Griselinia littoralis*, and *Fuchsia excorticata* are seen, while others occur which will considerably increase their range in altitude as given by Cheeseman.

The extensive shingle-slips of the Ruahine tops are worthy of a more searching examination, but a hasty one revealed a South Island shingle-plant hitherto unrecorded from the North Island in *Epilobium pycnostachyum*.

The flora of the Kaimanawa branch of the range is, unfortunately, much altered by introduced animals. It is, however, certainly a most promising field for future research, and will probably merit as distinct a treatment in description as do the Tararua or the main Ruahine ranges.

I am indebted to Dr. L. Cockayne, F.R.S., Mr. D. Petrie, and Mr. T. F. Cheeseman for much assistance and advice, ungrudgingly given at all times.

List of Indigenous Ruahine Mountain Plants.‡

[Note. — An asterisk (*) denotes that the plant has not been observed by the author, but is inserted on the authority of Colenso ("An Account of Visits to and Crossings over the Ruahine Mountain-range: Napier, 1884"), or Cheeseman ("Manual of the New Zealand Flora: 1906"). See also D. Petrie, "Account of a Visit to Mount Hector," with list of plants (Trans. N.Z. Inst., vol. 40, 1908, p. 289); and Aston, "Botanical Notes made on a Journey across the Tararuas" (Trans. N.Z. Inst., vol. 42, 1910, p. 13), "List of Phanerogamic Plants indigenous in the Wellington Province" (Trans. N.Z. Inst., vol. 43, 1911, p. 225), "Some Effects of Imported Animals on the Indigenous Vegetation" (Proc. N.Z. Inst., vol. 44, 1911, p. 19.) A dagger (†) denotes that the plant has a higher range in altitude than that assigned to it by Cheeseman.]

Clematis indivisa Willd. In lower forest, ascending to 1,900 ft.
—— *hexasepala* D.C. In lower forest, ascending to 2,100 ft.†
Ranunculus insignis Hook. f. Chiefly in herb-field and tussock meadow, 4,000–5,000 ft. Occurs occasionally on river-banks, 2,000–3,000 ft.†
—— *geraniifolius* Hook. f. 4,400–5,000 ft., in herb-field.
—— *hirtus* Banks & Sol. All stations, ascending to 3,150 ft.
Caltha novae-zealandiae Hook. f. In mountain bogs and wet places, 4,450–5,000 ft.
—— *obtusa** (?) Cheesem. "Probably from Ruahine Range." *T. F. C.*
Drimys axillaris Forst. Ascending to 2,000 ft.
—— *colorata* Raoul. Ascends to 3,800 ft.†
Cardamine hirsuta Linn. All stations up to 4,500 ft.
Viola filicaulis Hook. f. Ascending to 3,600 ft.
—— *Cunninghamii* Hook. f. Ascending to 4,000 ft.
Melicytus ramiflorus Forst. In lower forest, ascending to 2,550 ft.
—— *lanceolatus* Hook. f. Whariti, at 2,000 ft.
Pittosporum tenuifolium Banks & Sol. In lower forest, ascending to 2,700 ft.
—— *Colensoi* Hook. f. In forest, ascending from 2,550 ft. to 3,500 ft.†
—— *rigidum* Hook. f. Subalpine forest and scrub, 3,000–4,500 ft.†
—— *eugenioides* A. Cunn. In lower forest, ascending to 2,000 ft.†
Stellaria parviflora Banks & Sol. 2,000–4,000 ft.
Colobanthus Billardieri Fenzl. 4,000–5,000 ft.†
Claytonia australasica Hook. f. Shingle-slips at 4,500 ft.
Hoheria populnea A. Cunn. var. *lanceolata* Hook. f. An abundant constituent of the scrub at 3,650 ft. on slopes of Umutoi (easterly aspect). Ascending from 1,400 ft.†
—— —— var. *angustifolia* Hook. f. At 4,000 ft.†
Aristotelia racemosa Hook. f. All stations, ascending to 4,200 ft.†
—— *Colensoi* Hook. f. In higher forest, 2,550–4,200 ft.†
—— *fruticosa* Hook. f. In scrub, 3,500–4,500 ft.†
Elaeocarpus dentatus Vahl. In lower forest, ascending to 1,500 ft.
—— *Hookerianus* Raoul. In higher forest, 2,000–3,000 ft.
Geranium microphyllum Hook. f. Ascending to 4,500 t.†
Oxalis magellanica Forst. Ascending to 4,500 ft., on river-banks and shingle-slips.
Melicope simplex A. Cunn. In lower forest.
Pennantia corymbosa Forst. In lower forest, ascending to 2,000 ft.
Alectryon excelsum Gaertn. On Whariti, in lowest forest.
Coriaria ruscifolia Linn. On shingle-beds and river-banks to 3,500 ft.

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‡ Except where otherwise stated, "lower forest" means the forest occurring from 1,400 ft. up to 2,000 ft., and "higher forest" that between 2,000 ft. and 4,000 ft. Lowest forest was only observed from 200 ft. to 1,500 ft. at Whariti, near Woodville.

Coriaria thymifolia Humb. & Bonp. Extensive pure associations at foot of Mokai–Patea Ridge (westerly aspect) and loose-soil situations, ascending to 4,500 ft.
—— *angustissima* Hook. f. On slips at 3,600–4,500 ft.†
*Carmichaelia odorata** Col. River-banks, below 1,500 ft.
—— *flagelliformis* Col. River-sides, up to 2,100 ft.
Sophora tetraptera J. Mill. On river-flats at 1,450 ft.
Rubus australis Forst. Ascending through lower forest to 3,600 ft.†
—— *schmidelioides* A. Cunn. In lower forest to 1,450 ft.†
Geum parviflorum Smith. At 4,500 ft., on slip.
Acaena Sanguisorbae Vahl. var. *pilosa* Kirk. All stations, ascending to 4,500 ft.
—— *novae-zelandiae* Kirk.
Carpodetus serratus Forst. Ascending to 3,000 ft. in forest.
Weinmannia racemosa Linn. f. In lower forest, ascending to 2,500 ft.
Drosera stenopetala Hook. f. Mountain bogs, 4,500–5,000 ft.
—— *Arcturi* Hook. f. Mountain bogs, 4,300–5,000 ft.
Halorrhagis alata Jacq. Woodville Gorge.
Gunnera monoica Raoul. On damp banks.
Leptospermum scoparium Forst. Lowest slopes of Whariti.
—— *ericoides* A. Rich. Ascending to 2,700 ft. in higher forest.
Metrosideros florida Smith. In lower forest, Whariti.
—— *robusta* A. Cunn. In lower forest, Whariti.
—— *hypericifolia* A. Cunn. In lower forest, extending to 1,950 ft.
—— *Colensoi* Hook. f. In lower forest, at 1,650 ft.†
Myrtus bullata Sol. In lowest forest on Whariti.
—— *obcordata* Hook. f. In lower forest, at 1,650 ft.
—— *pedunculata* Hook. f. Ascending to 3,200 ft.†
Epilobium pubens A. Rich. Ascending to 4,000 ft.
—— *erectum* Petrie. Damp open places, ascending to 2,600 ft.†
—— *tenuipes* Hook. f. On river-flats.
—— *Hectori* Haussk. On river-flats.
—— *chloraefolium* Haussk. On vegetation lanes on shingle-slips, from 3,600 ft. to 4,500 ft. (northerly aspect).
—— *rotundifolium* Forst. In lower forest, ascending to 2,100 ft.†
—— *linnaeoides** Hook. f.
—— *nummularifolium* R. Cunn. Ascending to 3,150 ft.†
—— *macropus* Hook. On river-beds and slips, 2,100–4,500 ft.
—— *pycnostachyum* Haussk. On loose shingle at 4,500 ft. (northerly aspect), on Te Atua Mahura.
—— *melanocaulon* Hook. On river-shingle beds at 1,500 ft.†
—— *glabellum* Forst. On river-shingle up to 1,450 ft.
Fuchsia excorticata Linn. f. Ascending through lower forest to 3,600 ft.†
Azorella Haastii Benth. & Hook. f. On rock-faces at 4,400 ft.
Hydrocotyle elongata A. Cunn. In lower forest, ascending to 2,100 ft.†
—— *americana* Linn. In lower forest, ascending to 2,000 ft.
—— *novae-zealandiae* D.C. Lower forest.
Oreomyrrhis andicola Endl. From 4,400 ft. to 4,500 ft., in herb-field.
Aciphylla Colensoi Hook. f. In tussock meadow, 2,700–5,000 ft.†
Ligusticum aromaticum Hook. f. In tussock meadow and herb-field, 3,600–5,000 ft.
Angelica rosaefolia Hook. On river-cliffs at 1,450 ft.
Panax simplex Forst. In higher forest, from 2,500 ft. to 4,200 ft.†

Panax Edgerleyi Hook. f. Ascending through lower forest to 4,000 ft.†
—— *Sinclairii** Hook. f.
—— *Colensoi* Hook. f. Chiefly in higher forest, from 2,700 to 4,500 ft.
—— *arboreum* Forst. Ascending to 3,000 ft. on Mokai Ridge; but chiefly a lower-forest plant, up to 2,900 ft.†
Schefflera digitata Forst. Chiefly in lower forest, but ascends to 3,000 ft.
Pseudopanax crassifolium C. Koch. Ascending through lower forest to 3,200 ft.†
Griselinia lucida Forst. Epiphytic on trees in lowest forest, Whariti.
—— *littoralis* Raoul. Ascending through the forest to 4,200 ft. in subalpine gullies. Growing as a tree at intermediate altitudes, a bushy shrub in subalpine gullies, and a spindly shrub in lower forest.†
Alseuosmia quercifolia A. Cunn. In forest at 1,500 ft. on Whariti.
Coprosma robusta Raoul. Ascending through lower forest to 2,700 ft.†
—— *tenuifolia* Cheesem. Ascending from lower forest to 3,600 ft.
—— *grandifolia* Hook. f. Ascending through lower forest to 3,000 ft.†
—— *lucida* Forst. Ascending through lower forest to 3,700 ft.†
—— *rhamnoides* A. Cunn. In lower forest, ascending to 2,000 ft.
—— *parviflora* Hook. f. Ascending through lower forest to 4,200 ft. in subalpine scrub.†
—— *ramulosa* Petrie. From 3,600 ft. to 5,000 ft.; slips, herb-fields, and tussock meadow.
—— *linariifolia* Hook. f. On Mokai Ridge, at 2,550 ft., in forest.
—— *foetidissima* Forst. Ascending through forest to subalpine gullies, at 4,450 ft.
—— *Colensoi* Hook. f. Ascending from 3,000 ft. to 4,000 ft. in higher forest and scrub zone.†
—— *cuneata* Hook. f. From 3,400 to 5,000 ft. in higher-forest scrub and tussock meadow.
—— *microcarpa* Hook. f. Ascending to 3,150 ft. in forest, but occurs sometimes as an open-hillside shrub.†
—— *depressa* Col. In tussock meadow, 4,000–5,000 ft.
—— *repens* Hook. f. On slips, bogs, and tussock meadow, 3,600–4,500 ft.
Nertera depressa Banks & Sol. In lower forest.
—— *dichondraefolia* Hook. f. In lower forest, ascending to 3,600 ft.†
Galium umbrosum Sol.
Lagenophora petiolata Hook. f. In higher forest, 3,600–4,000 ft.
Brachycome Sinclairii Hook. f. On Mokai Ridge, 4,000–5,000 ft.
—— *odorata* Hook. f. On Mokai Ridge tussock meadow, 4,150 ft.†
Olearia Colensoi Hook. f. In higher forest and subalpine gullies, 3,000–4,450 ft.
—— *nitida* Hook f. Ascending through forest to subalpine scrub at 4,400 ft.†
—— *macrodonta** Baker.
—— *ilicifolia* Hook. f. In subalpine scrub at 3,200 ft.
—— *Cunninghamii* Hook. f. In lower forest, ascending to 2,500 ft.
—— *virgata* Hook. f. Mokai Ridge.
—— *Solandri* Hook. f. On lowest slopes of Whariti.
Celmisia incana Hook. f. 3,600–5,000 ft., in slips, tussock meadow, and herb-field.
—— *spectabilis* Hook. f. In tussock meadow and herb-field, 3,300–5,000 ft.†

Celmisia longifolia Cass. From 3,100 ft. to 5,000 ft.; river-bed, slip, tussock meadow, and herb-field.
—— *glandulosa* Hook. f. Often a mountain-bog plant, 3,600–5,000 ft.†
Vittadinia australis A. Rich. On dry lower grass lands and shingle-beds, 1,400 ft.
*Gnaphalium Lyallii** Hook. f.
—— *Keriense* A. Cunn. On river-banks, 2,100–3,150 ft.
—— *subrigidum* Col. Limestone faces, Manawatu Gorge, near Woodville.
—— *Traversii* Hook. f. var. *Mackayi*. In tussock meadow, 4,250 ft.
—— *paludosum* Petrie.
—— *luteo-album* Linn. Ascending to 1,400 ft.
—— *japonicum* Thunb. To 1,400 ft.
Raoulia grandiflora Hook. f. In herb-field, 4,000–4,500 ft.
—— *australis* Hook. f. In river-beds, at 2,000 ft.
Helichrysum Leontopodium Hook. f. About 5,200 ft., on rocks.
—— *glomeratum* Benth. & Hook. Ascending through the forest to 3,150 ft., on slips.†
—— *bellidioides* Willd. In river-beds and banks ascending to 4,500 ft., and on slips.
—— —— var. *prostratum* Kirk. Vegetation lanes on slips at 4,000 ft.
—— *filicaule* Hook. f. In lower pasture, 1,400 ft.
Cassinia Vauvilliersii Hook. f. Subalpine scrub and tussock meadow, 3,350–4,500 ft.
Craspedia uniflora Forst. On rocks and slips at 4,300 ft.
Abrotanella pusilla Hook. f. Mountain bogs, 4,500–5,000 ft.†
Cotula coronopifolia Linn. In gutters, lowest slopes of Whariti.
Brachyglottis repanda Forst. Ascending through lower forest to 2,700 ft.†
Senecio lagopus Raoul. On slips, tussock meadow, and herb-field, 3,600–4,500 ft.†
—— *lautus* Forst. var. *montanus* Cheesem. On slips at 4,450 ft.
—— *latifolius* Banks & Sol. Ascending through the forest to 4,000 ft., on slips and herb-fields.†
—— *Kirkii* Hook. f. Epiphytic, lower forest, Whariti.
—— *elaeagnifolius* Hook. f. In higher forest from 2,000 ft. to subalpine scrub at 4,600 ft.†
—— *Bidwillii* Hook. f. On slips, in tussock meadow, 4,450–5,000 ft.
Phyllachne Colensoi Bergg. In mountain bogs at 5,200 ft.
Oreostylidium subulatum Bergg. At 4,300 ft. in wet ground.†
Forstera Bidwillii Hook. f. At 4,300 ft. in wet ground.
—— *tenella** Hook. f.
Pratia angulata Hook. f. In river-beds, 1,400–2,100 ft.
Wahlenbergia saxicola A. D.C. Ascending to 4,450 ft. on slips.
—— *gracilis* A. D.C. Usually a lowland plant, 1,400 ft.
Gaultheria antipoda Forst. Ascending through forest to 4,400 ft.
—— *perplexa* T. Kirk. On Mokai Ridge, 3,000–4,000 ft.†
—— *rupestris* R. Br. In higher forest, scrub, and meadow, 3,350–4,400 ft.
Pentachondra pumila R. Br. Tussock meadow, 4,000–4,500 ft.
Cyathodes acerosa R. Br Ascending through forest to 3,150 ft.
—— *empetrifolia* Hook. f.
—— *Colensoi* Hook. f.
—— *pumila* Hook. f. Mountain bog and herb-field, 4,300–4,500 ft.
Leucopogon fasciculatus A. Rich. Ascending through forest to 3,700 ft.†
—— *Fraseri* A. Cunn. Ascending to 3,350 ft. on tussock meadow.

Epacris alpina Hook. f. Tussock meadow, at 3,600 ft.
Dracophyllum recurvum Hook. f. From slips at 3,600 ft. to tussock meadow at 5,000 ft.†
—— *longifolium* R. Br. In scrub, 3,000–3,200 ft.
—— *Urvilleanum* A. Rich. var. *filifolium* Hook. f. In scrub, 3,150–4,000 ft.
—— —— var. *montanum* Cheesem.
—— *subulatum* Hook. f.
Myrsine salicina Heward. In lower forest, ascending to 2,800 ft.
—— *Urvillei* A. D.C. In lower forest, to 1,450 ft.
—— *montana** Hook. f.
—— *divaricata* A. Cunn. In higher forest and scrub, 2,550–4,200 ft.
—— *nummularia* Hook. f. Under shade of rocks at 4,900 ft.
Olea Cunninghamii Hook. f. Lower forest, Whariti.
—— *lanceolata* Hook. f. In forest, at 2,000 ft.
Parsonsia heterophylla A. Cunn. In lower forest, at 2,000 ft.
—— *capsularis* R. Br. Ascends to 2,500 ft., Mokai Ridge (eastern aspect).†
Geniostoma ligustrifolium A. Cunn. In lower forest, 1,400–1,650 ft.†
Gentiana Grisebachii Hook. f.
—— *bellidifolia* Hook. f. Slips, bogs, and tussock meadow, 4,000–5,000 ft.
*Myosotis antarctica** Hook. f.
—— *Forsteri* (Lehm.) Cheesem. In temporary watercourse at 3,600–4,300 ft., Mokai Ridge.†
—— *petiolata** Hook. f.
Solanum aviculare Forst. Lowest slopes of Whariti.
*Calceolaria Sinclairii** Hook.
—— *repens** Hook. f.
*Gratiola nana** Benth.
Veronica salicifolia Forst. Ascending through forest to 4,000 ft.†
—— *parviflora* Vahl. In lower forest, 1,450–2,100 ft.†
—— *venustula*, Col.
—— *Colensoi** Hook. f.
—— *laevis* Benth. In river-beds at 1,500 ft. to slips and tussock meadow at 4,450 ft.
—— *buxifolia* Benth. Slips at 3,600 ft. to tussock meadow at 5,000 ft.
—— *Astoni* Petrie. In tussock meadow, rocks, and slips, 4,000–5,000 ft.
—— *catarractae* Forst. River-beds and slips, 1,450–3,150 ft.†
—— —— var. *diffusa* Hook. f. On slips at 4,500 ft.†
—— *Lyallii* Hook. f. Tussock meadow at 4,000 ft.
—— *Hookeriana** Walp.
—— *Olseni** Col.
—— *spathulata** Benth.
Ourisia macrophylla Hook. In river-beds, 1,450–2,100 ft.
—— *Colensoi* Hook. f. In higher forest, 3,150 ft., to tussock meadow at 4,450 ft.†
—— *caespitosa** Hook. f.
Euphrasia cuneata Forst. Ascending through the forest to 4,450 ft. on slips, the forms at higher levels corresponding to Colenso's *E. tricolor*.
—— *revoluta* Hook. f. In mountain bog, 5,000–5,200 ft.
—— *zealandica* Wettst. In bog and tussock meadow, 5,000 ft.
Myoporum laetum Forst. Lowest slopes of Whariti.
Plantago Brownii Rapin. At edges of tarns and mountain-creeks, in bogs, at 5,000 ft.

Plantago uniflora Hook. f. At edges of tarns and mountain-creeks, in bogs, at 5,000 ft.†
Rumex flexuosus Sol.
Muehlenbeckia australis Meissn. In lower forest, ascending to 2,000 ft.
—— *complexa* Meissn.
—— *axillaris* Walp. On river-shingle at 1,450 ft.
Hedycarya arborea Forst. Lowest forest on Whariti.
Laurelia novae-zealandiae A. Cunn. Lowest forest on Whariti.
Beilschmiedia tawa Benth. & Hook. f. Lowest forest on Whariti.
Pimelia Gnidia Willd.
—— *buxifolia* Hook. f. In tussock meadow at 4,300–4,500 ft.
—— *laevigata* Gaertn. Forms of this species occur on river-shingle, slips at all altitudes up to 4,300 ft.
—— *Lyallii** Hook. f.
Drapetes Dieffenbachii Hook. In tussock meadow at 4,500 ft.
Elytranthe tetrapetala Engl. Parasitic on *Fagus*, 2,100–3,700 ft.
—— *flavida* Engl. Parasitic on *Fagus*, 2,000–3,000 ft.†
Paratrophis heterophylla Bl. In lowest forest on Whariti.
Urtica incisa Poir. In lower forest at 2,000 ft.
Fagus fusca Hook. f. Ascending through lower forest to 3,250 ft.
—— *Solandri* Hook. f.
—— *cliffortioides* Hook. f. Ascending through lower and higher forest to 4,600 ft.†
Libocedrus Bidwillii Hook. f. In higher forest, 3,000–4,200 ft.†
Podocarpus totara Don. Ascending in forest to 3,600 ft.†
—— *Hallii* T. Kirk. In forest, 2,900–3,150 ft.
—— *nivalis* Hook. On slips and in tussock meadow, 4,300–5,000 ft.
—— *ferrugineus* Don. In lower forest, to 2,200 ft.
—— *spicatus* R. Br. In lower forest.
Dacrydium biforme Pilger. In forest at 3,000 ft.
—— *Bidwillii* Hook. f.
—— *cupressinum* Sol. In lower forest, ascending to 2,200 ft.
—— *intermedium* T. Kirk. Abundant on Whariti at 3,000 ft.
—— *laxifolium* Hook f. In tussock meadow and bog, 4,300–4,500 ft.†
Phyllocladus alpinus Hook. f. In higher forest, 3,000–4,200 ft.
Dendrobium Cunninghamii Lindl. In lower forest.
Earina mucronata Lindl. Ascending in forest to 2,600 ft.†
Thelymitra longifolia Forst. Ascending to 3,600 ft. in tussock meadow.
Prasophyllum Colensoi Hook. f. In tussock meadow, 3,600–4,450 ft.
Pterostylis Banksii R. Br. Ascending to 3,600 ft. on Mokai Ridge, in sub-alpine gullies.†
—— *australis* Hook. f. Ascending through higher forest from 2,700–3,700 ft.†
—— *foliata** Hook. f.
—— *venosa** Col.
Caladenia bifolia Hook. f. In tussock meadow and bog, 4,250–4,500 ft.
Chiloglottis cornuta Hook. f. On ridge in forest, 3,150 ft.
Corysanthes oblonga Hook. f.
—— *triloba* Hook. f. On wet banks, ascending to 4,200 ft.†
—— *macrantha* Hook. f. Ascending to 3,600 ft. on Mokai Ridge, in alpine gullies.†
Gastrodia Cunninghamii Hook. f. In lower forest at 1,900 ft.
Libertia ixioides Spreng. Ascending through forest to 3,100 ft. in *Phormium* belt.†

Libertia pulchella Spreng. In higher forest.
Rhipogonum scandens Forst. In lowest forest, Whariti.
Enargea marginata Banks & Sol. 3,000–3,600 ft. in higher forest.
Cordyline Banksii Hook. f. On river-banks and open spaces in forest, ascending to 2,700 ft.
—— *australis* Hook. f. Ascending to 2,100 ft. in lower forest.
—— *indivisa* Steud. Ascending through forest to 3,600 ft., where it occurs in great abundance in *Phormium* belt.
Astelia linearis Hook. f. In mountain bog, 4,300–5,000 ft.
—— *Cunninghamii* Hook. f. Forming extensive pure associations in forest floor, 1,900–3,200 ft.†
—— *Solandri* A. Cunn. Epiphytic or on forest floor, 2,000–3,000 ft.†
—— *nervosa* Banks & Sol. Ascending in forest to 4,400 ft.
—— —— var. *montana* Kirk. In tussock meadow, 4,000–4,900 ft.
Dianella intermedia Endl. In lower forest.
Phormium tenax Forst. Ascending through forest to 4,400 ft.†
—— *Cookianum* Le Jolis. Ascending through forest to 4,400 ft.†
Bulbinella Hookeri Benth. & Hook. f. In tussock meadow, 3,600–4,000 ft.
Juncus effusus Linn. At 4,350 ft., in wet tussock meadow.†
—— *novae-zealandiae* Hook. f. At 4,000 ft., in subalpine scrub.
*Luzula Colensoi** Hook. f.
—— *campestris* D.C. Ascending to 4,300 ft.†
Freycinetia Banksii A. Cunn. In lowest forest on Whariti.
Potamogeton Cheesemanii A. Benn. In mountain-pools on Mokai Ridge, at 4,300 ft.†
*Centrolepis pallida** Cheesem.
Hypolaena lateriflora Benth. In mountain bog at 4,300 ft.
*Scirpus aucklandicus** Boeck.
Carpha alpina R. Br. In mountain bog and tussock meadow, 4,200–4,500 ft.
Schoenus pauciflorus Hook. f. In mountain bog and wet ground, 4,250–5,000 ft.
Cladium Sinclairii Hook. f. On wet river-cliffs at 1,450 ft.
Gahnia pauciflora T. Kirk. In lowest forest.
Oreobolus pumilio R. Br. var. *pectinatus* C. B. Clarke. In mountain bog. 3,600–5,200 ft.†
Uncinia compacta R. Br. At 4,300–5,000 ft., in tussock meadow.
—— *australis* Pers. In lower forest, ascending to 3,000 ft.
—— *fusco-vaginata* Kuk.
—— *rupestris** Raoul.
—— *filiformis* Boott.
*Carex pyrenaica** Wahl.
—— *stellulata* Good. In boggy ground at 4,300 ft.†
—— *acicularis** Boott.
—— *virgata* Sol. In swampy ground, lower slopes of Whariti.
—— *secta* Boott. In swampy ground, lower slopes of Whariti.
—— *inversa* R. Br.
—— *ternaria* Forst. var. *gracilis* Cheesem. Near creek, at 4,300 ft.†
—— *lucida* Boott. Lower slopes of Whariti.
—— *testacea* Sol.
—— *Forsteri* Wahl. Lower slopes of Whariti.
Ehrharta Colensoi Hook. f. Tussock meadow, 4,000–4,500 ft.
Microlaena stipoides R. Br. Lower grass lands.
—— *avenacea* Hook. f. In forest, ascending to 3,000 ft.

*Microlaena polynoda** Hook. f.
Hierochloe redolens R. Br. Ascending to 4,000 ft.†
—— *Fraseri* Hook. f. On slips and in tussock meadow, 3,600–4,500 ft.
*Agrostis Muelleri** Benth.
—— *Dyeri* Petrie. On tussock meadow, about 4,000 ft.
Deyeuxia Forsteri Kunth. On tussock meadow, about 4,000 ft.†
—— *avenoides* Buch. var. *brachyantha* Hack.
Deschampsia tenella Petrie.
Trisetum antarcticum Trin.
—— *Youngii* Hook. f.
Danthonia Cunninghamii Hook. f. In higher forest, 3,000–4,000 ft.†
—— *Raoulii* Steud. In tussock meadow, 3,300–5,200 ft.
—— *semiannularis* R. Br. var. *setifolia* Hook. f.
—— *pilosa* R. Br. In lower grass land, at 1,400 ft.
Arundo conspicua Forst. Ascending in lower forest to 2,100 ft.
Poa anceps Forst. Ascending in forest to 3,500 ft.
—— *caespitosa* Forst. In tussock meadow at 4,350 ft.†
—— *Colensoi* Hook. f. On slips and tussock meadow, 3,300–4,500 ft.
—— *Kirkii* Buch. In tussock meadow at 4,300 ft.
—— *imbecilla* Forst. In higher forest and meadow to 4,400 ft.†
Festuca ovina Linn. var. *novae-zealandiae* Hack. In tussock meadow at 4,150 ft.†
—— *rubra* Linn.

Plants of the Kaimanawa Branch Range.

Clematis hexasepala D.C. Ascending to 3,500 ft.†
Ranunculus nivicola Hook. Waipakihi River, upper reaches, at 3,000 ft.
—— *hirtus* Banks & Sol. Ascending to 3,500 ft.
—— *rivularis* Banks & Sol. Ascending to 4,000 ft.†
Drimys axillaris Forst. Ascends to 3,500 ft.†
Cardamine hirsuta Linn. Ascends to 4,500 ft.
Viola filicaulis Hook. f. Ascending to 4,500 ft.†
—— *Cunninghamii* Hook. f.
Hymenanthera crassifolia Hook. f. At 3,600 ft.†
Pittosporum Colensoi Hook. f. Ascends to 3,500 ft.
Colobanthus Billardieri Fenzl. Ascends to 4,500 ft.
—— *Muelleri* T. Kirk.
Claytonia australasica Hook. f. Ascending to 5,000 ft.
Montia fontana Linn. In creeks, 2,500 ft.
Aristotelia racemosa Hook. f. Ascends to 3,500 ft.†
—— *Colensoi* Hook. f. Ascends to 4,500 ft.†
—— *fruticosa* Hook. f. Ascends to 4,500 ft.†
Eleocarpus Hookerianus Raoul. Ascends to 3,500 ft.†
Linum monogynum Forst. At 2,100 ft.†
Geranium dissectum Linn Ascends to 3,400 ft.†
—— *sessiliflorum* Cav.
Oxalis magellanica Forst. Ascends to 4,500 ft.†
Coriaria ruscifolia Linn. Ascending to 3,000 ft.
—— *thymifolia* Humb. & Bonp. Ascending to 3,000 ft.
—— *angustissima* Hook. f. Ascending to 4,500 ft.†
Carmichaelia Enysii T. Kirk var. *orbiculata* T. Kirk. From 3,600 ft. to 4,600 ft.†
—— *subulata* T. Kirk. Hitherto recorded from South Island only.

Carmichaelia flagelliformis Col. Ascending to 4,000 ft.†
Sophora tetraptera J. Mill. Ascending to 3,000 ft.†
Rubus australis Forst. Ascending to 4,000 ft. in forest.†
Geum parviflorum Smith. At 4,500 ft., in creek.
Acaena Sanguisorbae Vahl. Ascending to 3,400 ft.
—— *microphylla* Hook. f.
Carpodetus serratus Forst. Ascending to 3,450 ft.†
Drosera Arcturi Hook. f. 4,500–5,000 ft., in mountain bogs.
—— *spathulata* Labill. Ascending to 5,000 ft., in mountain bogs.†
Halorrhagis alata Jacq. At 2,100 ft.†
—— *depressa* Walp.
—— *micrantha* R. Br. Ascending to 4,500 ft.†
Gunnera dentata T. Kirk. In wet ground at 4,100 ft.†
Callitriche verna Linn. In moist places and creeks, 3,500 ft.
Leptospermum scoparium Forst. Ascending to 5,000 ft.†
Myrtus pedunculata Hook. f. Ascending to 3,500 ft.†
Epilobium junceum Sol Ascends to 3,000 ft.
—— *erectum* Petrie. Ascends to 3,500 ft.
—— *pubens* A. Rich. Ascends to 4,500 ft.†
—— sp. nov. A chasmophyte on shady side of greywacke rocks at 3,600 ft.
—— *tenuipes* Hook. f. Ascends to 3,500 ft.†
—— *alsinoides* A. Cunn.
—— *chloraefolium* Haussk. Ascends to 4,500 ft.
—— *insulare* Haussk. At 3,500 ft., in damp places.†
—— *rotundifolium* Forst. Ascends to 3,500 ft.†
—— *nummularifolium* R. Cunn. Ascends to 3,500 ft.†
—— *macropus* Hook. In creek, at 4,500 ft.
—— *melanocaulon* Hook. Ascends to 3,000 ft., on river-flats.†
—— *microphyllum* A. Rich. Ascends to 3,000 ft., on river-flats.
—— *glabellum* Forst. Ascends to 3,500 ft.
Fuchsia excorticata Linn. f. Ascends to 3,500 ft.†
Hydrocotyle tripartita R. Br. var. *hydrophila* Petrie. On spray-washed boulders in creeks, about 4,000 ft.†
—— *novae-zealandiae* A. D.C. At 4,100 ft.†
Azorella Hookeri Drude. Ascends to 3,500 ft.†
Aciphylla Colensoi Hook. f. Ascends to 5,300 ft.†
—— *squarrosa* Forst. Ascends to 3,500 ft.
—— —— var. From 3,000 ft. to 4,000 ft. The dwarf variety, hitherto undescribed.†
Ligusticum aromaticum Hook. f. Ascends to 5,000 ft.†
Angelica Gingidium Hook. f. At 2,100 ft. Erewhon Station.
—— *rosaefolia* Hook. At 2,100 ft. Erewhon Station.†
Panax simplex Forst. Edge of forest, ascending to 3,500 ft.
—— *Edgerleyi* Hook. f. Ascending to 3,500 ft.†
—— *anomalum* Hook. Ascends to 3,500 ft.†
—— *Sinclairii* Hook. f. 1,000–3,500 ft.
—— *Colensoi* Hook. f. Ascending to 4,700 ft.†
Pseudopanax crassifolium C. Koch. Ascending to 3,500 ft.†
Corokia Cotoneaster Raoul. Ascending to 3,500 ft.†
Griselinia littoralis Raoul. Ascending to 4,000 ft.
Coprosma tenuifolia Cheesem. Ascending to 3,500 ft.
—— *parviflora* Hook. f. Ascends to 4,700 ft.†
—— *ramulosa* Petrie. At 4,500 ft.

Coprosma linariifolia Hook. f. At 2,950 ft.
—— *foetidissima* Forst. Ascends to 3,900 ft.
—— *Colensoi* Hook. f. 1,000–3,500 ft.
—— *cuneata* Hook. f. 2,000–5,000 ft.
—— *microcarpa* Hook. f. Ascending to 3,500 ft.†
—— *depressa* Col. At 3,400–4,400 ft.
—— *repens* Hook. f. Ascending to 5,000 ft.
Nertera depressa Banks & Sol. At 3,500 ft.
Lagenophora pumila Cheesem. At 3,500 ft.†
—— *petiolata* Hook. f. At 3,000–3,600 ft.
Brachycome Sinclairii Hook. f. Rare.
Olearia furfuracea Hook. f. Hitherto not recorded from Wellington Province. Erewhon Station, at 3,000 ft.†
—— *nitida* Hook. f. Ascending to 4,500 ft.†
—— *nummularifolia* Hook. f. 2,000–5,000 ft.†
—— *virgata* Hook. f. var. *ramuliflora* T. Kirk. At 4,100 ft.†
Celmisia spectabilis Hook. f. Ascending from 2,000 ft. to 5,300 ft.†
—— *longifolia* Cass. Ascending to 4,700 ft.
—— *glandulosa* Hook. f. At from 3,600 ft. to 4,500 ft.
Vittadinia australis A. Rich. Ascending to 3,000 ft.
Gnaphalium Keriense A. Cunn. Ascends to 3,500 ft.†
—— *subrigidum* Col. Moawhango Gorge Road, 2,000 ft.
—— *paludosum* Petrie. Ascends to 4,700 ft.†
—— *luteo-album* Linn. Ascends to 3,500 ft.†
—— *japonicum* Thunb. Ascends to 3,500 ft.†
Raoulia australis Hook. f. Ascends to 5,550 ft.
—— *tenuicaulis* Hook. f. Ascends to 5,550 ft.†
—— *grandiflora* Hook. f. Not common; 4,500–5,000 ft.
Helichrysum bellidioides Willd. Ascending to 4,200 ft.
—— *Leontopodium* Hook. f. From 4,500 ft. to 5,000 ft.
—— *glomeratum* Benth. & Hook. f. Ascends to 3,000 ft.†
Cassinia Vauvilliersii Hook. f. Ascends to 5,000 ft.†
Craspedia uniflora Forst. var. *lanata* Hook. f. Ascending to 5,000 ft.
Brachyglottis repanda Forst. Ascends to 3,000 ft.†
Senecio lagopus Raoul. Ascending to 4,300 ft.
—— *lautus* Forst. Ascending to 3,500 ft.
—— *latifolius* Banks & Sol. At 3,500 ft.
—— *Bidwillii* Hook. f. From 3,000 ft. to 5,000 ft.
Microseris Forsteri Hook. f. Ascending to 4,600 ft.†
Oreostylidium subulatum Bergg. In bogs, at 4,000 ft.
Forstera Bidwillii Hook. f. From 4,500 ft. to 5,300 ft.
Selliera radicans Cav. At 3,500 ft.†
Pratia angulata Hook. f. Ascending to 4,500 ft.
Wahlenbergia gracilis A. D.C.
—— *saxicola* A. D.C. Ascending to 5,200 ft.
Gaultheria antipoda Forst. Ascending to 5,000 ft.
—— *perplexa* T. Kirk. At 4,900 ft.†
—— *rupestris* R. Br. Ascending to 5,300 ft.†
Pentrachondra pumila R. Br. At 4,100–5,300 ft.†
Cyathodes acerosa R. Br. Ascends to 4,000 ft.†
—— *Colensoi* Hook. f. 2,000–5,000 ft.
—— *pumila* Hook. f. At 5,000 ft., in wet places.
Leucopogon fasciculatus A. Rich. Ascending to 3,500 ft.

Leucopogon Fraseri A. Cunn. Ascending to 5,000 ft.†
Epacris alpina Hook. f. Ascends to 5,000 ft.†
Dracophyllum recurvum Hook. f. Ascends to 5,000 ft.†
—— *Urvilleanum* A. Rich. 2,500–4,500 ft.
—— *subulatum* Hook. f. Ascends to 3,500 ft.
Myrsine divaricata A. Cunn. From 3,400 ft. to 3,900 ft.
—— *nummularia* Hook. f. 2,000–5,000 ft.
*Logania depressa** Hook. f. From Colenso's description, which was consulted in the field, there is no doubt that this plant was found on the Kaimanawa Mountains.
Gentiana Grisebachii Hook. f.
—— *bellidifolia* Hook. f. 4,000–5,000 ft.
Liparophyllum Gunnii Hook. f. In bogs at 4,700 ft.†
Myosotis Forsteri Lehm. Ascends to 4,300 ft.†
Veronica salicifolia Forst. Ascends to 4,600 ft.†
—— *angustifolia* A. Rich. Ascends to 4,300 ft.†
—— *parviflora* Vahl. Ascends to 4,300 ft.†
—— *Colensoi* Hook. f. River-flats, at 3,000 ft.†
—— *laevis* Benth. Ascends to 5,000 ft.
—— *buxifolia* Benth. Ascends to 5,000 ft.†
—— *tetragona* Hook. 2,000–5,000 ft. Persistent young state on river-flats at 3,000 ft.
—— *catarractae* Forst.
—— —— var. *diffusa* Hook. f. Ascends to 4,000 ft.†
—— *tuberculosa* D. Petrie nov. sp., MS. Headwaters of Moawhango River, at 4,000 ft.
Ourisia macrophylla Hook. Ascends to 4,500 ft.
—— *Colensoi* Hook. f. Ascends to 5,000 ft.†
—— *caespitosa* Hook. f. Ascends to 5,000 ft.
Euphrasia cuneata Forst. Ascends to 5,000 ft.
—— *revoluta* Hook. f. At 3,400 ft.
—— *zealandica* Wettst. Ascends to 5,000 ft.
Utricularia monanthos Hook. f. In running bog, 4,700 ft.†
Mentha Cunninghamii Benth. At 2,600 ft.†
Scleranthus biflorus Linn. On rocks at 3,000 ft.
Rumex flexuosus Sol.
Muehlenbeckia complexa Meissn. At 3,500 ft.†
—— *axillaris* Walp. From 3,000 ft. to 4,400 ft.
Pimelia buxifolia Hook. f. At 4,600 ft.
—— *laevigata* Gaertn. Ascends to 5,300 ft.†
Elytranthe tetrapetala Engl. Ascends to 4,000 ft. Sometimes parasitic on *Dracophyllum subulatum.*
—— *flavida* Engl. Ascends to 3,500 ft.†
Urtica incisa Poir. Ascending to 3,500 ft.
Fagus Menziesii Hook. f. At 3,000 ft., in sheltered gorge.
—— *fusca* Hook. f. Ascending to 3,500 ft.
—— *Solandri* Hook. f. At 3,500 ft.†
—— *cliffortioides* Hook. f. Ascending to 4,400 ft.
Podocarpus totara Don. At 3,900 ft.†
—— *Hallii* T. Kirk.
—— *nivalis* Hook. From 3,400 ft. to 5,300 ft.
Dacrydium Bidwillii Hook. f. In tussock meadow, 4,000–5,000 ft.
—— *laxifolium* Hook. f. Ascends to 5,000 ft.†

Phyllocladus alpinus Hook. f. From 3,500 ft. to 4,700 ft.
Thelymitra longifolia Forst. At 3,500 ft.
Prasophyllum Colensoi Hook. f. Ascends to 5,300 ft.†
Pterostylis Banksii R. Br. At 3,500 ft.
Chiloglottis cornuta Hook. f. Ascends to 3,000 ft.
Corysanthes triloba Hook. f. Ascends to 4,200 ft.†
—— *macrantha* Hook. f. Ascends to 3,500 ft.†
—— *oblonga* Hook. f.
Libertia ixioides Spreng. Ascends to 3,500 ft.†
Cordyline indivisa Steud. At 3,000 ft.
Astelia nervosa Banks & Sol. Ascending to 4,000 ft.
Phormium tenax Forst. At 3,000 ft.
Bulbinella Hookeri Benth. & Hook. From 2,000 ft. to 4,500 ft.
Herpolirion novae-zealandiae Hook. f. From 3,500 ft. to 4,600 ft.†
Juncus effusus Linn. At 3,500 ft.†
—— *novae-zealandiae* Hook. f. Ascends to 4,500 ft.
Luzula campestris D.C. Ascends to 5,200 ft.
Potamogeton polygonifolius Pourr. Ascends to 4,700 ft.†
Centrolepis viridis T. Kirk. 2,000–5,000 ft.
Hypolaena lateriflora Benth. In bogs, 4,500–5,300 ft.†
Eleocharis acuta R. Br. Ascends to 3,500 ft.†
Scirpus lenticularis Poir.
Carpha alpina R. Br. Extends to 5,000 ft.
Schoenus pauciflorus Hook. f. 2,000–3,500 ft
—— *nitens* Poir. var. *concinnus* Hook. f.
Oreobolus strictus Bergg. 3,500–5,000 ft.†
Uncinia compacta R. Br.
—— *rubra* Boott. At 3,000 ft., in pasture.
Carex ternaria Forst. At 3,500 ft.
—— *lucida* Boott. Ascends to 3,500 ft.†
—— *Petriei* Cheesem. Ascends to 3,500 ft.
—— *dissita* Sol. Ascends to 3,500 ft.
—— *Forsteri* Wahl. At 2,100 ft.†
Microlaena avenacea Hook. f. Ascends to 3,500 ft.†
Hierochloe redolens R. Br. At 3,500 ft.†
—— *Fraseri* Hook. f.
Agrostis muscosa T. Kirk. From 3,200 ft. to 4,100 ft.
—— *Dyeri* Petrie.
Deyeuxia setifolia Hook. f.
Trisetum antarcticum Trin.
—— *Youngii* Hook. f.
Danthonia Raoulii Steud. Ascending to 5,300 ft. Variety with red leaves at 3,000–3,600 ft.†
—— *semiannularis* R. Br. var. *setifolia* Hook. f. Ascending to 5,300 ft.
Arundo conspicua Forst. Ascending to 3,500 ft.†
Poa anceps Forst. Ascending to 3,500 ft.
—— *caespitosa* Forst. Ascending to 4,400 ft.†
—— *Colensoi* Hook. f. At 3,400–5,000 ft.
Festuca ovina Linn. var. *novae-zealandiae* Hack. At 2,000–3,600 ft.
Agropyrum scabrum Beauv. At 2,000–3,600 ft.

ART. X.—*Plant-habitats Hitherto Unrecorded.*

By B. C. ASTON, F.I.C., F.C.S.

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

IN this paper I have endeavoured to embody discoveries which may be either (1) a genuine extension of the known range of distribution of a plant (and not merely a habitat confirmatory of those mentioned in standard floras of New Zealand), or (2) a correction of a generalization which is found to be incorrect, or (3) a confirmation of the occurrence of a rare species.

Lepidium obtusatum T. Kirk. Seatoun ; on beach and rocks.

Melicytus micranthus Hook. f. Near Rotorua ; Bishop's Bush, Horoeka, Puketoi Range ; Whiskers Bush, Feilding. This shrub is a comparatively rare plant in Wellington Province.

Hymenanthera obovata T. Kirk. The Titahi Bay form (see Trans. N.Z. Inst., vol. 42, 1910, p. 46) occurs at Port Nicholson Heads.

Pittosporum rigidum (?) Hook. f. Horoeka, in Puketoi Range.

Entelea arborescens R. Br. Paekakariki ; by margin of creek.

Aristotelia Colensoi Hook. f. Ruahine Mountains, 3,500 ft.

Pomaderris elliptica Lab. Common on the eastern lower slopes of Pirongia Mountain, on fern and scrub country, at about 600 ft. elevation. It is a conspicuous component of the formation in September, owing to the beautiful yellow flowers. Mr. Cheeseman writes me that this is quite a new locality to him, and the most southerly known on the west side of the North Island.

Discaria Toumatou Raoul. Head of Palliser Bay. An uncommon plant in Wellington Province.

Carmichaelia nana Col. Kaimanawa Mountains, 3,000–4,000 ft., near Moawhango.

—— *subulata* T. Kirk. Kaimanawa Mountains.

Geum parviflorum Sm. Kaimanawa Mountains, 4,000–5,000 ft.

Metrosideros Colensoi Hook. f. Fairly common in south of Wellington Province.

Epilobium insulare Haussk. Kaimanawa Mountains, 3,000–4,000 ft.

—— *pycnostachyum* Haussk. Shingle-slips at 5,000 ft. on Te Atua Mahura, Ruahine Mountains. Hitherto recorded from the South Island only.

Tillaea diffusa T. Kirk. Breaker Bay, near Seatoun.

Hydrocotyle tripartita R. Br. var. *hydrophila*. Kaimanawa Mountains, 3,000–4,000 ft.

Aciphylla intermedia Petrie. Table-top, Mount Dennan ; Quoin, 3,900 ft. ; Mount Dundas, 3,950 ft. : all on Tararua Mountains.

—— *polita* Cheesem. Mount Richmond, Marlborough. *A. Morris Jones !*

Angelica geniculata Hook. f. Wainuiomata mouth.

—— *rosaefolia* Hook. Oarenga River cliffs, Kaimanawa Mountains ; Ruahine Mountains.

Coprosma ramulosa Petrie. Kaimanawa Mountains, 5,000 ft.

Olearia furfuracea Hook. f. Kaimanawa Mountains, 4,000 ft.

—— *virgata* Hook. f. Waikaka, Hauraki Plains (the most northerly station yet recorded) ; Kaimanawa Mountains.

Celmisia Macmahoni T. Kirk. Mount Richmond. *A. Morris Jones!*
—— *glandulosa* Hook. f. Ruahine Mountains.
Gnaphalium subrigidum Col. Moawhango Gorge, near Taihape; near Dannevirke; Cape Turnagain; near Martinborough. *Miss M. E. Farrow!* This last is the most southerly station yet recorded.
Senecio Colensoi Hook. f. Cape Turnagain.
Oreostylidium subulatum Bergg. Kaimanawa Mountains, 4,100 ft.
Cyathodes pumila Hook. f. Ruahine and Kaimanawa Mountains, 5,000 ft.
Sebaea ovata R. Br. Cape Turakirae, Palliser Bay.
Myosotis Forsteri Lehm. Kaimanawa Mountains.
Veronica angustifolia A. Rich. Kaimanawa Mountains.
—— *parviflora* Vahl. Kaimanawa Mountains.
Teucridium parviflorum Hook. f. Taumarunui.
Elytranthe Colensoi Engl. Growing on forty-year-old oak, Takapau, Wharaungo, Havelock, Marlborough. *A. Morris Jones!*
—— *tetrapetala* Engl. Parasitic on *Dracophyllum subulatum*, in Kaimanawa Mountains, at 3,500 ft.
Korthalsella Lindsayi Engl. Wainuiomata mouth, on *Muehlenbeckia Astoni.*
Paratrophis Banksii Cheesem. Mana Island.
Fagus Menziesii Hook. f. Absent from the Ruahine Mountains from 2,000–4 500 ft.
Potamogeton pectinatus L. In creek near Cape Turnagain.
Oreobolus strictus Bergg. Ruahine Mountains, 5,000 ft.
Uncinia compacta R. Br. Kaimanawa Mountains; Disappointment Island, and Port Ross, in Auckland Island group.
Microlena polynoda Hook. f. Waihi Falls, near Weber; Whiskers Bush, near Feilding.
Lomaria fluviatilis Spreng. At 3,600 ft. on Ruahine Mountains.

Art. XI.—*On a Subalpine Element in the Flora of Banks Peninsula.*

By R. M. Laing, M.A., B.Sc.

[*Read before the Philosophical Institute of Canterbury, 6th August 1913.*]

There is to be found on the hill-tops of Banks Peninsula a plant association of a totally different character from that which clothes, or has recently clothed, the lower portions of the hills. This association, though consisting of species which often reach sea-level in the southern parts of New Zealand, may be termed "subalpine," in that on Banks Peninsula it is generally found at altitudes of 2,000 ft. and upwards, though in places some of the species belonging to it extend downwards to 1,500 ft. (as on Cooper's Knobs), or even lower. There are traces of it on the Lyttelton Hills, it is more conspicuous on Cooper's Knobs, and it is abundant on Mount Herbert, Mount Fitzgerald, and Mount Sinclair, the highest points of the peninsula. It is found, as a rule, most fully developed on the southern sides of the hills. These are generally rockier and steeper than the northern flanks, and, being exposed to the south-westerly winds and rains, are generally colder and moister than the drier northern faces, which are exposed more fully to the rays of the sun.

On Mounts Fitzgerald and Sinclair the subalpine element is best developed. Several species occur there which I have not found elsewhere. On approaching the latter mountain from the south-east by the old Purau line we find the bush suddenly disappear at about 2,600 ft., and the remaining portion of the peak is covered with a subalpine meadow, approaching, however, in some of its characteristics to a fellfield. The plant association is composed chiefly of *Danthonia flavescens* (var. apparently intermediate between *D. flavescens* and *D. Raoulii*), interspersed with *Achiphylla Colensoi*, *Hierochloe redolens*, *Danthonia semiannularis*, *D. Cunninghamii*, *Phormium Cookianum*, and tufts of *Poa Colensoi*. A little farther up, *Raoulia glabra*, *Wahlenbergia saxicola*, *Anisotome aromatica*, *Drapetes Dieffenbachii*, and *Ourisia macrophylla (forma)* make their appearance. None of these yet mentioned, except *Hierochloe redolens*, *Poa Colensoi*, and *Danthonia semiannularis* are to be found lower down the mountain-side. On Mount Fitzgerald other subalpine forms appear. Amongst these may especially be noted an unexpected form of *Veronica Lyallii*. This species I have not seen elsewhere on the peninsula. Indeed, several of the species here show some variation from the typical forms. This is perhaps not to be wondered at, as the *Ourisia* and *Veronica* are not to be found nearer than Porter's Pass, fifty miles away. It is almost to be expected that, as far at least as alpine plants are concerned, these hill-tops should present the characteristics of an insular flora. The nearest point to the peninsula at which *Drapetes* occurs is Mount Gray, some thirty-odd miles to the northward.

Between Mounts Sinclair and Fitzgerald is to be seen the beginnings of a subalpine scrub, consisting of *Dracophyllum uniflorum* var. *acicularifolium*, *Myrsine divaricata*, *Olearia ilicifolia*, and *O. nummularifolia*—an unexpected species, not to be found elsewhere on the peninsula, so far as I know. A silvery-white form of *Acaena Sanguisorbae* is also abundant between this point and Mount Herbert, and is occasionally to be met with elsewhere.

On the south-eastern slopes of the peninsula there has been a *Nothofagus* forest, which perhaps may also be included under the term "subalpine," as it occupied chiefly the tops of the hills. It is now nearly completely destroyed; but at one time it stretched along the tops of the ridges behind Long Bay* to Damon's Bay, outside Akaroa Heads. The forest crosses the ridge to the Akaroa side of the hills immediately behind the town near the Stony Bay track, but I have not been in this portion of it. It probably does not descend anywhere below 1,500 ft. The species of beech represented in it are *Nothofagus fusca*, *N. cliffortioides*, and *N. Solandri*. *N. fusca* is there in largest quantity, and often in magnificent specimens. *N. Solandri* is found on the ridge immediately behind Long Bay, varying much in the form of its leaf, which sometimes approaches that of *N. Blairii*. Small quantities of *N. cliffortioides* are intermingled with it. *Cordyline indivisa* and *Panax Colensoi*, which are not common elsewhere on the peninsula, occur within or on the edges of the forest, together with a considerable number of other species which, however, are elsewhere abundant on the peninsula.

The presence of this subalpine element is perhaps to be expected on hills which reach to an altitude of 3,000 ft., particularly when it is remembered that many of the species here recorded come to a lower level elsewhere.

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* This is the Long Bay on the eastern side of the peninsula.

It may, however, be pointed out that on the same hills many northern species find their southernmost limit, at least on the east coast—*e.g.*, *Macropiper excelsum*, *Alectryon excelsum*, *Passiflora tetrandra*, *Dodonaea viscosa*, *Rhopalostylis sapida*, *Corynocarpus laevigata*, and *Hedycarya arborea*. The lower valleys of the hills are almost subtropical in character, whilst the hilltops have a vegetation similar to that of the adjacent alps. The contrast is a striking one, as within 2,000 ft. one can pass from a coastal flora with strong resemblances to that of Nelson or Wellington to a plant association of a subalpine type. Indeed, though containing fewer species, the association at the tops of Mounts Sinclair and Fitzgerald are very similar to those met with at similar or somewhat greater heights on the Canterbury mountains between Mount Torlesse and Mount Gray.

It should, perhaps, be mentioned here that the existence of this subalpine florula was pointed out as long ago as 1869 by Sir Julius von Haast (Trans. N.Z. Inst., vol. 2, p. 118), who, in classifying the main zones of vegetation in Canterbury, writes thus: "Subalpine zone . . . It ranges from 2,500 ft. to 4,500 ft., and includes the lower portion of the interior of the province and the highest summits of Banks Peninsula." No attempt, however, so far as I know, has been made to describe the phytogeography of this locality, except in so far as there are species from it recorded in the lists of Messrs. J. F. and J. B. Armstrong, in vols. 2 and 12 of the Transactions.

The following species, recorded by Mr. J. F. Armstrong, might be expected to appear in this list, but I have not seen them on Banks Peninsula: *Craspedia alpina*, *Epilobium crassum*, *Veronica Raoulii*. The same may be said of the following additional species recorded by Mr. J. B. Armstrong: *Ranunculus pinguis*, *Acaena adscendens*, *Drosera binata*, *Epilobium purpuratum*, *Pozoa hydrocotyloides*, *Ligusticum piliferum*, *Celmisia coriacea*, *C. Lyallii*, *C. spectabilis*, *Cotula pectinata*, *C. pyrethrifolia*, *Raoulia tenuicaulis*, *Myrsine nummularia*, *Myosotis capitata*, *Veronica cupressoides*, *Euphrasia Monroi*. Most of these have clearly been recorded in error; others possibly have once existed on the peninsula, but have now become extinct. It is barely possible that one or two of them may still be found.

Attached is a list of the species that may be regarded as confined to the mountain-summits of the peninsula.

Whether this florula is to be regarded as a collection of waifs and strays or the remnant of a more widespread flora of glacial times I shall not endeavour to discuss here.

List of Species.

[Those marked with an asterisk have apparently not been recorded hitherto from Banks Peninsula.]

1. *Aciphylla Colensoi** Hook. f.
2. *Anisotome aromatica* Hook. f. Cooper's Knobs, and generally abundant above 1,800 ft.; also on The Tors (Lyttelton Hills).
3. *Anisotome Enysii* (?) (T. Kirk) Laing. Castle Rocks, Heathcote, One Tree Hill, hills behind Akaroa; occasionally found below 1,000 ft.
4. *Cordyline indivisa* Steud. Near the Akaroa Summit Road and in beech forests.
5. *Danthonia flavescens* Hook. f. Common above 1,500 ft.
6. *Dracophyllum uniflorum* Hook. f. var. *acicularifolium* Cheesem. Cooper's Knobs, and common above 1,800 ft.
7. *Drapetes Dieffenbachii* Hook. f. Common above 2,000 ft.

8. *Lagenophora pinnatifida** Hook. f. Summit of French Peak, and at edge of beech forest, and on northern ridge of Waikerakikeri Bay.
9. *Gaultheria antipoda* Forst. var. *depressa* Hook. f. Mounts Fitzgerald and Sinclair.
10. *Gunnera monoica* Raoul. Ridges behind Akaroa.
11. *Libocedrus Bidwillii* Hook. f. From Mount Sinclair to hills behind Akaroa.
12. *Myosotis pygmaea* Col. Possibly not uncommon, but easily overlooked. Though elsewhere found at sea-level, this is only to be seen on the hill-tops of the peninsula. Doubtless the greater amount of moisture there has determined the situation. This is probably true also of *Lagenophora pinnatifida*, which I found only on the very summit of French Peak, and on the top of the ridge elsewhere.
13. *Myosotis australis* R. Br. Lyttelton Hills; rare (with white flowers only).
14. *Nothofagus cliffortioides** (Hook. f.) Oerst. Long Bay Ridge.
15. *Nothofagus Solandri* (Hook. f.) Oerst. Long Bay Ridge.
16. *Nothofagus fusca* (Hook. f.) Oerst. Stony Bay to Damon's Bay.
17. *Olearia ilicifolia** Hook. f. Mount Sinclair (2,500 ft.), Purple Peak. Sometimes found at lower altitudes on the peninsula.
18. *Ourisia macrophylla (forma)* Hook. Common above 2,000 ft., forming matted patches which cover the ground to the exclusion of all other vegetation. The plant is always creeping; petioles, midribs, and veins pilose, upper surface and margins of the leaves more sparsely covered with short hairs. Leaves membranous, capsule $\frac{1}{4}$ in. long or less. Flowers, December to February. The same form occurs at Reefton, and doubtless elsewhere on the West Coast.
19. *Oxalis magellanica** Forst. Mount Fitzgerald.
20. *Pentachondra pumila* R. Br. Brasenose only.
21. *Raoulia australis* Hook. f. Purple Peak only. Originally found by Raoul; now apparently almost extinct.
22. *Raoulia glabra** Hook. f. Common above 2,000 ft.; Lyttelton Hills, very rare.
23. *Schizeleima Hookeri** (Drude) Donin. Rare; Mount Pleasant, Lyttelton, behind Governor's Bay, near sea-level in Checkley's Bush (Akaroa).
24. *Senecio lagopus* Raoul. Turf hill-tops behind Akaroa.
25. *Senecio saxifragoides* Hook. f. A common chasmophyte above 1,000 ft., generally on the south-west faces of the hills.
26. *Uncinia rubra* Boott. in Hook. f. Tops of Mounts Fitzgerald and Sinclair, and probably elsewhere.
27. *Veronica Lavaudiana* Raoul. Abundant, and coming down to 900 ft.
28. *Veronica Lyallii (forma)* Hook. f. Forming dense patches, often covering many square yards on the southern faces of the cliffs on Mount Fitzgerald. Leaves $\frac{1}{10}$ in. to $\frac{1}{4}$ in. long, with only two serratures on each. Racemes 1 in. to 2 in. long, rising from near the ends of the branches; apparently a dwarf form. The plant has the leaves of *V. Bidwillii*, with the inflorescence of *V. Lyallii*.
29. *Wahlenbergia saxicola** A. D.C. Top of Mount Sinclair. Though elsewhere at sea-level, here only on the highest summits.

Art. XII.—*Some Hitherto-unrecorded Plant-habitats (IX).*

By L. Cockayne, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 5th November, 1913.*]

For the determination of the mosses recorded below I am indebted to Mr. H. N. Dixon, M.A., F.L.S. Mr. C. E. Christensen, in company with Mr. W. G. Morrison, of the State Nursery, is continuing his valuable detailed examination of the Hanmer district, and the Rev. J. E. Holloway has sent me a collection of plants from Mount Oxford. To these gentlemen I am much indebted.

1. Musci.

Barbula australasiae (Hook. & Grev.) Brid.

South Island: Canterbury—On soil on rock, Port Hills. L. C.

Breutelia comosa Mitt.

South Island: Canterbury—Growing amongst large stones in the open, neighbourhood of Tasman Glacier. Johannes Andersen!

Bartramia patens Brid.

South Island: Canterbury — Wet rock, Craigieburn Mountains, at 1,000 m. altitude. L. C.

Bryum curvicollum Mitt.

North Island: Auckland—Wet ground in the open, Ohaupo. L. C.

Bryum leptothecium Tayl.

South Island: Canterbury—Port Hills. Miss Suckling!

Campylium relaxum (Hook. f. & Wils.).

South Island: (1.) Westland—Forest floor near Jackson's, Taramakau Valley; L. C. (2.) Canterbury—Floor of *Nothofagus* forest, base of Craigieburn Mountains, at 700 m. altitude; L. C.

Campylopus introflexus (Hedw.) Mitt.

South Island: Westland — Lowland *Sphagnum* moor near Stafford. L. C.

Dicranoloma pungens (Hook. f. & Wils.) Paris.

South Island: Canterbury—Totara forest near source of River Rakaia, at 920 m. altitude. L. C.

Dicranoloma setosum (Hook. f. & Wils.) Paris.

South Island: Otago—*Nothofagus* forest near Queenstown. W. Willcox!

Ditrichum elongatum Mitt.

South Island: Canterbury—On rock, Port Hills. L. C.

Grimmia pulvinata (L.) Hook. & Tayl. var. **obtusa** (Brid.) C. M. & W. P. Schimp.

South Island: Canterbury—On rock, Port Hills. L. C.

Hypnum sarmentosum Wahl.

South Island: Canterbury—In shallow water, Craigieburn Mountains, at 1,200 m. altitude. L. C.

Homalia falcifolia Hook. f. & Wils.

South Island: Canterbury—Port Hills. Miss Suckling!

Lembophyllum divulsum (Hook. f. & Wils.) Lind.

South Island: Canterbury—In forest, Port Hills. Miss Suckling!

Leptostomon inclinans R. Br.

South Island: Canterbury—Epiphytic on *Olearia ilicifolia*, totara forest near source of River Rakaia, at 910 m. altitude. L. C.

Leptodon Smithii Mohr.

South Island: (1.) Canterbury — Totara forest near source of River Rakaia, at 910 m. altitude; L. C. (2.) Port Hills; Miss Suckling!

Macromitrium longipes (Hook.) Schwaegr.

South Island: Westland—Epiphytic in forest near terminal face of Franz Josef Glacier. L. C.

Mnium rostratum (Schrad.) Schwaegr.

South Island: Canterbury—Port Hills. Miss Suckling!

Pohlia cruda.

South Island: Canterbury—Epiphytic on *Olearia ilicifolia*, totara forest near source of River Rakaia, at 910 m. altitude. L. C.

Ptychomion aciculare (Brid.) Mitt.

South Island: (1.) Westland — Floor of forest near Jackson's, Taramakau Valley; L. C. (2.) Canterbury — Forest on Port Hills; Miss Suckling!

Rhacomitrium symphiodon Mitt.

South Island: Westland — Forms first vegetation on face of *roche moutonnée*, Franz Josef Glacier. L. C.

Rhacopilum strumiferum (C. M.) Jaeg.

North Island: Auckland—Epiphytic in forest of north. L. C.

Tortula kowaiensis R. Br. ter.

South Island: (1.) Marlborough—*Nothofagus* forest, Awatere Valley, at 1,000 m. altitude; L. C. (2.) Canterbury—Totara forest near source of River Rakaia, at 910 m. altitude; L. C. (3.) *Nothofagus* forest, base of Craigieburn Mountains; L. C.

Tridontium tasmanicum Hook. f.

North Island: Auckland — North of the province, but habitat uncertain. L. C.

Weymouthia Billardieri.

South Island: Westland—Epiphytic, hanging from slender branches of shrubs in forest near Franz Josef Glacier. L. C.

2. Spermophytes.

Angelica geniculata (Forst. f.) Hook. f.

South Island: Nelson—(1.) Island in River Waiau, at Marble Point; C. Christensen! (2.) Base of Shale Peak, Waiau Valley; C. Christensen and W. G. Morrison!

This plant has now been recorded from so many stations far inland that it can hardly be considered a coastal species.

Celmisia intermedia Petrie.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Celmisia pseudo-Lyallii (Cheesem.) Cockayne.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Clematis australis T. Kirk.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Coriaria thymifolia Humb. & Bonp.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Cotula fiiliformis Hook. f.

This plant, recorded by me last year (Trans. N.Z. Inst., vol. 45, p. 254) with a certain degree of doubt as to its true name, has since been compared with the type at Kew by Dr. O. Stapf, F.R.S., to whom I am greatly indebted. Dr. Stapf writes that it exactly matches the type. The plant forms wide patches by means of its very slender, brown, wiry, creeping stems furnished with short roots. The leaves are oblong, 1–2 cm. long by 5 mm. wide or less in the widest part, green or stained brown near the base, thin, glabrous, deeply pinnatifid, with the subulate segments either entire or sparsely toothed on the upper margin; the leaf-base is broad, sheathing, pale and very thin, and encloses the bud. The scapes are filiform, slightly pilose, and at most 5 cm. long; the head is about 4 mm. in diameter. In cultivation the plant grows with great rapidity, and seems well able to hold its own in competition with *Oxalis magellanica* and *Cotula pyrethrifolia*.

Cotula pyrethrifolia Hook. f.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Drapetes Dieffenbachii Hook. f.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Epilobium chloraefolium Hausskn.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Forstera Bidwillii Hook. f.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Haastia recurva Hook. f.

South Island: Nelson—On shingle-slip near summit of Mount Percival. C. E. Christensen and W. G. Morrison!

Helichrysum glomeratum (Hook. f.) Benth. & Hook.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Korthalsella Lindsayi (Oliver) Engl.

South Island: (1.) Nelson—Island in River Waiau, near Marble Point; parasitic on *Angelica geniculata* and *Sophora microphylla*. C. E. Christensen! (2.) Old forest of Canterbury Plain, near Christchurch (Deans' Bush). C. E. Foweraker!

Mr. Christensen states that the plant grows far more luxuriantly on *Sophora* than on *Angelica*, a happening obviously in harmony with the smaller food-supply provided by the latter.

Myosotis pygmaea Col.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

In my opinion, *Myosotis antarctica* Hook. f., of Campbell Island, is amply distinct from any of the forms in New Zealand proper hitherto referred to that species, and as Colenso's *M. pygmaea* is obviously one of the forms of the aggregate species, and, so far as I know, the first name published, I am using it for the present to include *all* the forms in New Zealand of what have hitherto been called *M. antarctica*.

Nertera Balfouriana Cockayne.

South Island: Southland—Riverton flats. J. Crosby Smith!

Olearia arborescens (Forst. f.) Cockayne and Laing.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Olearia ilicifolia Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Ourisia caespitosa Hook. f.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Pimelea Lyallii Hook. f.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Phyllachne Colensoi (Hook. f.) Berggren.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway

Pittosporum Ralphii T. Kirk.

North Island: Hawke's Bay—Growing on the banks of rivers in company with *Sophora grandiflora* and *Hoheria sexstylosa*, in the northern part of the province. A frequent and characteristic plant. L. C.

This species is mentioned not because the habitat is new, but in order to emphasize the abundance of the species and to define its habitat conditions.

Pratia macrodon Hook. f.

South Island: Canterbury—Fellfield, Mount Oxford. J. E. Holloway!

Pratia perpusilla Hook. f.

North Island: Hawke's Bay—Growing on flat rock near margin of lake where water can lie after rain, Lake Waikaremoana. L. C.

This habitat is not new, for it is given by Cheeseman (Manual, p. 398), but there is no information as to the conditions under which the plant is growing.

Raoulia Beauverdii Cockayne nom. nov. — *R. Monroi* Beauv. in Bull. Soc. Bot. Geneva, vol. 4 (1912), p. .

South Island: (1.) Otago — Steppe of Central Otago; common. (2.) Southland—Sand-dunes along Foveaux Strait. L. C.

Upon reading Beauverd's descriptions of *R. Monroi* and *R. Cheesemanii* in the paper cited above I felt convinced that a mistake had been made, and consequently sent specimens of *R. Cheesemanii* Beauv. (*R. Monroi* Hook. f.) to Dr. O. Stapf, F.R.S., so that they could be compared with the type at Kew. Dr. Stapf replied by return of post confirming my opinion, and stating that the specimens exactly matched the type of *R. Monroi* Hook. f. It is quite easy to see how Beauverd was misled, for Hooker did not mention the distichous arrangement of the leaves, a most obvious character, that at once separates *R. Monroi* from any other species, and consequently seeing a plant with distichous leaves he concluded it must be "new." Also, both by Kirk ("Students' Flora," p. 303) and Cheeseman (Manual, p. 330) nothing is said as to distichous leaves, for both these authors united the true *R. Monroi* to an Otago plant with leaves in several ranks, the *R. Monroi* Beauv., in fact, giving the name *R. Monroi* to the joint species. Thus the synonomy of *R. Beauverdii* Cockayne is *R. Monroi* Beauv., *R. Monroi* T. Kirk in part, and *R. Monroi* Cheesm. in part. That my identification of the Southland sandhills' plant is correct is supported by the fact that Kirk (*l.c.*) gives Riverton Beach as the southern limit of the species, where the only other species of *Raoulia* is *R. australis*. Regarding the distichous leaves, I may mention that Mr. R. Brown, our late member, first called my attention to them as an excellent specific character. I give no description of the species, for Beauverd's, illustrated by an excellent figure, is admirable.

Rhagodia nutans R. Br.

South Island: Nelson—Island in the River Waiau near Marble Point. C. E. Christensen!

This is a remarkable station for a plant supposed to be coastal.

Senecio cassinioides Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Veronica pinguifolia Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Veronica Traversii Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

ART. XIII.—*Descriptions of the Ova of some of the* Lepidoptera *of New Zealand.*

By MORRIS N. WATT.

[*Read before the Wanganui Philosophical Society, 11th August, 1913.*]

Plates I, II.

I SHOULD first like to express my thanks to Mr. G. V. Hudson, of Wellington, whose kindness and help in identifying many of the species the eggs of which are described herein have been of no small assistance and encouragement to me. I am also greatly indebted to Mr. R. Murdoch, who gave me most valuable help in the preparation of the drawings and photographs. I shall always recognize a heavy debt of gratitude to both Mr. Hudson and Mr. Murdoch.

This paper is practically opening up a new branch of entomology in New Zealand. Hitherto the study of the eggs of our *Lepidoptera* has hardly been touched upon, though a beginning was made by the late Mr. Ambrose Quail, whose papers on the subject appear in the Transactions (vol. 33, p. 159, pl. ix; vol. 34, p. 226, pl. xiii). It has only been during the last few years that the importance of the subject has been recognized in England and on the Continent, and even in this short time an abundance of new and important scientific data has been published. Formerly entomologists confined themselves to elaborate and extensive descriptions of the adult insects only, considering the study of the larvae and ova as of no importance; these were small and often microscopically minute, and were therefore unworthy of notice. This idea is now exploded, and even more importance is being attached to the accurate descriptions of the primary forms of life and their development than to that of the adult forms.

Turning now to the paper itself, there are one or two items and terms that need some explanation. The eggs of all *Lepidoptera* are divisible into two classes or groups, known technically as "upright" and "flat" eggs. The shell is divisible into a base, walls, and apex. At the apex there is, as a rule, a microscopic depression, from the base of which minute canals lead into the egg, and carry the spermatozoa for the purpose of fertilization. This is known as the micropyle. The external characteristics of the micropyle generally take the form of a rosette of minute, delicately sculptured, elongated cells. We are now in a position to define the terms "upright" and "flat": if the egg be so laid that the micropylar axis is horizontal to the surface on which it is laid it is called a "flat" egg, and if laid so that the micropylar axis is vertical to the surface on which it is laid it is termed an "upright" one. Although the micropyle is actually at the apex in an "upright" egg, yet, on the other hand, it is at one extremity of the long axis in "flat" eggs. The term "base," as hitherto used by lepidopterists, is a doubtful quantity. It may be that side by which the egg is usually attached to the surface of the food plant or other object on which it may be deposited by the parent, or, on the other hand, the side opposite the micropyle may be termed the "base." It follows, therefore, that we speak of a Noctuid egg as being laid on its base, and, to get rid of the anomaly, we speak of a Geometrid egg as being laid on its long side. We use the term "base" as being the side opposite the micro-

pyle, as tending to preserve correctly the homologies of the egg-structures. Similarly, when describing the shape of certain eggs, the terms "longitudinal" and "transverse" sections have been used as meaning sections of the egg taken parallel or transversely to the micropylar axis.

As regards the size and sculpturing of the eggs of *Lepidoptera*, there is no need to go exhaustively into the subject here. To avoid confusion, it must be said that sometimes the eggs of the same species of moth or butterfly, and even individual eggs of a batch laid by the same parent, will differ slightly in size and sculpture: for instance, should an egg be ribbed with raised reticulations it may be found that in some eggs there are, say, fifteen such ribs, while in other eggs of the same moth, or of the same batch, there are seventeen, or perhaps only fourteen, of these reticulations. Where this occurs in the species described the limiting cases have been given. If, however, the variation is only very slight, the word "about" has been inserted before the statement. In many eggs the sculpturing is in the form of reticulations crossing and recrossing each other, and dividing the shell up into more or less deep figures: these depressions are termed "cells." The shell of the egg of a lepidopterous insect consists of a thin pellicle, more or less transparent, and sometimes opaque, and besides the main sculpturing sometimes gives rise to a secondary sculpturing, or it may be quite smooth, or more or less roughened. It must be remembered that all descriptions of the different portions of eggs mentioned herein are as seen through varying powers of the microscope, and that which may seem smooth when viewed under an inch power may turn out to be quite the opposite when seen through a half-inch or quarter-inch objective. A high power has in every case been used when describing such portions of the egg-structure.

The reason why such elaborate descriptions are needed is that in many cases the sole difference in the eggs of totally different species may lie entirely in the exact measurement of the eggs themselves, or even of only a portion of the eggs; or, again, in the slight variation in the sculpturing that is not at once apparent, but has to be sought out by means of series of microscopically minute and delicate measurements. Instances of such constantly occur among the *Porina*, *Melanchra*, and other groups.

Care has been taken to give all the more important synonyms of the species in every case, but it must not be concluded that the lists given are exhaustive; they are not. In almost every case reference has been made to Mr. R. W. Fereday's "Synonymic List of the *Lepidoptera* of New Zealand,"* where the complete lists of synonyms are given. Where the adult form of the ovum under consideration has been figured, reference to such has been given.

Porina cervinata Walk.

Elhamma cervinata Walk., Cat. Lep. Brit. Mus., Suppl. ii, p. 595. *Porina vexata, ib.*, p. 597. *P. cervinata* Butl., Cat. Lep. N.Z., p. 5; Meyr., Trans. N.Z. Inst., 22, p. 208; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 329; Hudson, N.Z. Moths and Butterflies, p. 133, pl. 13, fig. 12.

I have only taken two females of this species. They are much attracted by light, and the ones I took were resting at the time on a street-lamp.

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* Trans. N.Z. Inst., vol. 30, p. 326.

Ovum.

Class.—Flat (?).

Shape.—Viewed from above, oval. Transverse section, circular.

Dimensions.—Length, 0·65 mm.; diameter, 0·58 mm.

Sculpture.—The whole egg, except the micropylar cap, is completely covered with thousands of extremely minute protuberances, twice as high as wide. These are transparent, and reflect the light from all directions, giving the egg a white-dusted appearance.

Micropyle.—Micropylar cap darker than rest of egg, free from protuberances, oval in shape, bounded by an irregular thin white marking, slightly raised. At either end of the micropylar cap is a small deep circular cell; these together comprise the micropyle. Measurements: Total length of micropylar cap, 0·09 mm.; total width of same, 0·05 mm.; length of same within white margin, 0·05 mm.; width ditto, 0·03 mm.; distance between micropylar cells, 0·04 mm. These measurements are necessary, as will be seen on comparing the eggs of other species of this genus with the one here described.

Shell.—Opaque; slightly shiny; very strong; sometimes gets much dented without any apparent harm to the embryo; retains its shape and colour after the larva has emerged.

Colour.—When fresh laid, pale dirty-cream colour, changing within twenty-four hours to black. No further change. Infertile eggs do not seem to turn black, for I obtained a number of eggs of the original pale-cream colour that proved to be infertile, and which did not turn black, but quickly collapsed. Other eggs that did turn black did not hatch, but this may have been due to causes other than being infertile.

Note.—The parent moth lays an enormous number of eggs; one that I had laid over 1,200 in two days, and in another case 300 were laid in a few hours. The eggs are laid in no particular manner, but are dropped anywhere quite indiscriminately, and are in no way attached to any object or to each other. Some eggs seemed to have large areas free of the protuberances before referred to, but on being examined under a high power this proved not to be so, the effect being produced, I think, by the collection of moisture between the elevations, which interfered, naturally, with their reflecting-powers, and, since they are transparent, gave the effect of bare patches on the shell. The larva eats its way out at the micropylar end, but otherwise does not injure the shell in any way; it is very sluggish in its movements. Period of incubation, about thirty-one days.

(Described, 10th October, 1912.)

Porina umbraculata Guén.

Pielus umbraculatus Guén., Ent. Mo. Mag., 5, p. 1 (1868). *Porina umbraculata* Butl., Cat. Lep. N.Z., p. 5; Meyr., Trans. N.Z. Inst., 22, p. 209; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 330; Hudson, N.Z. Moths and Butterflies, p. 134, pl. 13, fig. 14.

Very common at Wanganui, and can be taken in great abundance on lamp-posts on a close night just before rain.

Ovum.

Class.—Flat (?).

Shape.—As seen from above, oval. Transverse section circular. Micro pylar end slightly flattened.

Dimensions.—Length, 0·65–0·58 mm.; diameter, 0·58 mm.

Sculpture.—Similar to that of *Porina cervinata.* The protuberances are slightly smaller.

Micropyle.—Similar to that of *Porina cervinata*, only the white margin around the platform is wanting. The protuberances cease within 0·02 mm. of the platform. The dimensions are: Length of platform, 0·05 mm.; width of platform, 0·03 mm.; distance between cells, 0·02 mm.

Shell.—Opaque; slight sheen; very strong; retains its shape and colour after the emergence of the larva. Gets much dented without any apparent harm to the larva.

Colour.—When fresh laid, pale cream, turning to steel-grey, and in twelve hours to black with very slight green tinge.

Note.—The same remarks *re* protuberances, infertile eggs, and mode of laying apply here as to *Porina cervinata.* Lots of 626, 503, 343, 205 eggs obtained; in all cases all these eggs were laid in one night. Laid, 3rd November; hatched, 5th December = thirty-two days.

(Described, 5th November, 1912.)

Porina characterifera Walk.

Hepialus characterifera Walk., Cat. Lep. Brit. Mus., Suppl. ii, p. 594 (1865); Butl., Cat. Lep. N.Z., p. 5. *Oxycanus impletus, ib.*, p. 598. *Porina characterifera* Meyr., Trans. N.Z. Inst., 22, p. 208; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 329; Hudson, N.Z. Moths and Butterflies, p. 12, pl. 13, fig. 11.

Several of this rare and beautiful species were caught on Mount Egmont (elevation 3,000 ft.) in January of this year (1913). It was very plentiful, flying high and extremely swiftly. Mr. Hudson, in his "New Zealand Moths and Butterflies," records four only as having been caught; but many more have, I think, been caught since. The moths did not seem to be at all attracted by light.

Ovum.

Class.—Flat (?).

Shape.—Oval. Transverse section circular.

Dimensions.—Length, 0·88 mm.; diameter, 0·65 mm.

Sculpture.—Similar to that of the egg of *P. cervinata.*

Micropyle.—The micropylar platform is oval and slightly raised, with a shallow moat surrounding it; darker than rest of egg, and covered with the small protuberances that cover the rest of the egg. The micropyle consists of two small deep circular cells about 0·01 mm. apart.

Shell.—Opaque; strong; slight sheen; retains its shape and colour after emergence of the larva. Gets very dented in some cases without apparent harm to embryo.

Colour.—When fresh laid, pale green, turning within twelve hours to black. No further change.

Note.—Laid indiscriminately, at fairly long intervals, and not attached in any way to plants or other objects. The remarks about the infertile eggs of *P. cervinata* apply here also. The moth lays an enormous number of eggs, though only thirty-three were obtained. Period of incubation is about thirty days.

(Described 8th January, 1913.)

Nyctemera annulata Boisd.

Leptosoma annulatum Boisd., Voy. de l'Astr., Ent., 5, p. 197. *Nyctemera doubledayi* Walk., Cat. Lep. Brit. Mus., 2, p. 392. *N. annulata* Butl., Cat. Lep. N.Z., p. 4; Meyr., Trans. N.Z. Inst., 22, p. 218; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 331; Hudson, N.Z. Moths and Butterflies, p. 2, pl. 4, figs. 1, 2.

One of our commonest moths in Wanganui during early and late summer. It is to be seen throughout the day, but is most plentiful in the early morning.

Ovum. Plate I, fig. 7.

Class.—Upright.

Shape.—As seen from above, circular. Vertical section: Base flat; sides diverging to the equator, converging above; top half of egg somewhat pointed; extreme top flat.

Dimensions.—Height, 0·70 mm.; diameter, 0·84 mm.; diameter of flat top, 0·12 mm.

Sculpture.—The shell is covered with minute elevations joined by exceedingly fine reticulations, forming five-, six-, and seven-sided figures, all more or less irregular in shape. Diameter of cells, about 0·02 mm. Mr. Ambrose Quail* says that he has come across batches of these ova which were quite smooth. I have noticed the same thing myself, but when the eggs were properly illuminated and viewed with a high power the cell-structure became quite plain.

Micropyle.—Situated in rosette of nine elongated cells. The cells of the network immediately surrounding the rosette are somewhat elongated in a direction radial from the micropyle. Diameter of rosette, 0·06 mm.; diameter of micropyle, 0·01 mm.

Shell.—Strong; transparent; shiny; roughened and slightly pitted within the cells when viewed with a high power.

Colour.—When fresh laid, pale yellow, intensifying in a day or so to deep yellow. In thirteen days a small brown area appears to one side of the micropyle, and in another day or so the whole egg changes to light grey, and the larva is plainly distinguishable. The long black hairs of the larva are very plain, and give the egg a most curious striated look.

Note.—Laid in small batches of ten or more. Not very firmly attached to food plant, and but slightly to each other, most often not touching at all. In a few days after being laid the upper surface of the egg gets slightly dented. One hundred and fifteen eggs obtained from one moth. Laid, 11th November; hatched, 27th November = sixteen days.

(Described, 17th November, 1912.)

Melanchra lignana Walk.

Hadena lignana Walk., Cat. Lep. Brit. Mus., 11, p. 543. *Xylophasia morosa* Butl., Cist. Ent., 2, p. 543. *Mamestra lignana* Meyr., Trans. N.Z. Inst., 19, p. 26; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 335. *Melanchra lignana* Hudson, N.Z. Moths and Butterflies, p. 26, pl. 5, fig. 19.

This pretty moth is very common at Wanganui during the early summer.

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* Trans. N.Z. Inst., vol. 34, p. 228.

Ovum. Plate II, fig. 6.

Class.—Upright.

Shape.—Hemispherical; top and bottom flattened, and of equal area.

Dimensions.—Diameter, 0·75–0·79 mm.; height, 0·58 mm.; diameter of top or bottom, 0·28 mm.

Sculpture.—Very pronounced. From the micropyle about fourteen high, semi-transparent, very thin ribs radiate towards the equator, converging below. At a slight distance from the equator, on the upper portion, of the egg, they are joined by other similar but alternate ribs, making about twenty-six longitudinal ribs in all. Finer reticulations traverse the egg at right angles to the micropylar axis, continuing up the sides and over the longitudinal ribs. The cells so formed are deep, show modified hexagon formation, and are longest in the direction parallel to the transverse reticulations. The dimensions of the cells around the equator are—length, 0·09 mm.; width, 0·02 mm.; depth, 0·02–0·03 mm. These, of course, diminish in length as they approach the micropyle. The base of the egg is slightly reticulated by the continuance of the longitudinal ribs. The number of longitudinal ribs is not constant.

Micropyle.—Situated in a rosette of ten to fourteen elongated cells surrounded by a band of fifteen hexagonal cells from which the longitudinal ribs originate. The rosette is raised within a depression in the top of the egg, and the micropyle is sunk crater-like in it. Measurements: Diameter of micropyle, 0·01 mm.; diameter of rosette, 0·08 mm.; length of hexagonal cells surrounding rosette 0·04 mm., width 0·03 mm.

Shell.—Strong; transparent; highly glossy; smooth within cells.

Colour.—Pearly white. In about a week a narrow band of light brown surrounds the egg just above the equator, and a small irregular area of light brown covers the micropyle. Four days later the light brown intensifies to a much darker shade, and the rest of the egg turns a light grey. At this stage the larva can be seen within the egg. Just before hatching the reticulations become white and very distinct. Infertile eggs turn slightly yellow, and collapse.

Note.—Laid singly and in small lots of four or five. Well attached to object, but not to each other. In one batch of fifty-six the eggs were arranged in neat regular rows, but not touching each other. Laid in November and December. The period of incubation is about eleven days. Larva emerges through the top of the egg to one side of the micropyle, and makes its first meal off the shell.

(Described, 17th November, 1912.)

Melanchra mutans Walk.

Hadenda mutans Walk., Cat. Lep. Brit. Mus., 11, p. 602. *H. lignifusca* Walk., *ib.*, p. 603. *Mamestra angusta* Feld., Reise der Nov., pl. cix, fig. 18. *M. mutans* Meyr., Trans. N.Z. Inst., 19, p. 17; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 333. *Melanchra mutans* Hudson, N.Z. Moths and Butterflies, p. 18, pl. 4, figs. 34, 35, 36.

One of our commonest moths in Wanganui; taken in great numbers at "sugar," and much attracted by light.

Ovum. Plate II, figs. 1 and 5.

Class.—Upright.

Shape.—Transverse section circular. Longitudinal section: Base flat, top slightly flattened, sides bulged, equator equidistant from the poles.

Dimensions.—Height, 0·44 mm.; diameter, 0·61–0·65 mm.

Sculpture.—Similar to that of *M. insignis.* Exceptions: Total number of ribs, 33–40; dimensions of cells at equator—length 0·05 mm., width 0·02 mm. The length of the cells is taken at right angles to the longitudinal ribs.

Micropyle.—A small deep circular cell situated in the centre of a rosette of eleven elongated cells. The rosette is slightly elevated, and is surrounded by a band of about twenty elongated cells, about twice as long as broad, lengthened in direction radial from the micropyle, dimensions being—length about 0·05 mm., width about 0·03 mm. There is a second band of irregular pentagonal and hexagonal cells from which the main ribs originate. Diameter of micropyle, 0·01 mm.; rosette, 0·08 mm.

Shell.—Transparent; fairly strong; shiny; slightly roughened within reticulations.

Colour.—When fresh laid, creamy white, changing in about four days to a light-brown mottling on upper half of egg. On the fifth day the upper surface of the egg (above the equator) is light brown with small creamy-white areas surrounding the micropyle. Below the equator the colour remains pearly white till near the date of hatching. In seven days the colour is a dark blackish-grey, a slight mottling still apparent. Just before hatching the colour gets much lighter in shade, and the creamy area below the equator turns a very light grey. The hairs of the larva are very plain at this stage, and the reticulations become white and very plain. Infertile eggs collapse without undergoing changes in colour.

Note.—These eggs are laid in batches in neat regular rows; sometimes there are two, and even three, tiers of eggs in one batch. Well attached to food plant, and slightly to each other. Batches obtained in April and October to December, consisting of from 180 to 92 eggs. Period of incubation fourteen to eleven days, according to weather. The parent moth does not always confine herself to laying only one batch, sometimes laying two, or even three, or more. When the eggs are first laid they are very soft, and are often pressed into irregular shapes by their neighbours, but this does not seem to affect them in any way. The larvae emerge through the top of the egg to one side of the micropyle, and make their first meal off the empty shell. I have found hundreds of batches of these eggs on the underside of the leaves of the white magnolia, and several batches on the underside of the leaves and on the bark of the red flowering gum. The moth also often lays her eggs on windows and walls of houses and other seemingly most unsuitable places.

(Described, 17th April, 1912.)

I add here descriptions of eggs belonging to two varieties of this moth (*Melanchra mutans*) which are very common. These differ quite enough to make one believe at first sight that they belong to different species.

VARIETY A.

Ovum.

The main differences in this egg are as follows:—

Dimensions.—Height, 0·37 mm.; diameter, 0·65 mm.

Sculpture.—Total number of ribs, 43–45; cells about 0·02 mm. square. Ribs 0·02–0·03 mm. apart at equator. The cells here do not show the modified hexagon form.

Micropyle.—Situated in rosette of about seventeen elongated cells. Diameter of rosette, 0·06 mm.; diameter of micropyle, 0·02 mm.

Colour.—When fresh laid, pale green; this slightly intensifies till the fourth day, when a light-brown ring appears around the equator and a large irregular area of light brown caps the egg. The brown areas are spotted with numerous small light-coloured areas, and get much darker in colour till a day or so before hatching, when they turn a blackish-grey, and then get much lighter in colour—in fact, almost a light grey. The hairs of the larva are most conspicuous. The green areas do not change till the day before hatching, when they assume a very light grey tint. Infertile eggs remain green, and collapse.

Note.—Period of incubation, from nine to fourteen days. Eggs laid in batches of from 200 to 67.

(Described, 10th November, 1912.)

VARIETY B.

Ovum.

The following important characteristics distinguish this egg:—

Shape.—Transverse section circular. Longitudinal section: Sides regular and bulged, top and bottom flat and of equal area. These eggs have the appearance of having been subjected to pressure from above and below between two flat surfaces.

Dimensions.—Height, 0·42 mm.; diameter, 0·63 mm.; diameter of top or bottom, about 0·37 mm.

Sculpture.—About nineteen main ribs. Total number of ribs about thirty, whose distance apart at the equator is about 0·06 mm. Transverse reticulations are about 0·03 mm. apart. The cells show modified hexagon form.

Micropyle.—There is no second band of hexagonal cells surrounding the micropyle. The following measurements are important: Diameter of rosette, 0·07 mm.; diameter of micropyle, 0·015 mm.; length of hexagonal cells surrounding rosette, 0·03 mm.; width of ditto, 0·02 mm.

Colour.—Light green. The surface of the egg above the equator is peppered with numerous small light-brown spots; later the reverse is the case, the surface being dark brown with a few small scattered light-brown areas, which as the rest intensifies are in most cases entirely lost.

Note.—Laid in no definite order, but in large scattered groups of about 100 eggs. Infertile eggs remain green, and collapse.

(Described, 27th November, 1912.)

The eggs of *M. mutans* seem to be very subject to attacks of parasites, and I have found thousands of the eggs destroyed in this way.

Melanchra insignis Walk.

Euplexia insignis Walk., Cat. Lep. Brit. Mus., 33, Suppl. iii, p. 724. *Xylina turbida, ib.*, p. 754; Butl., Cat. Lep. N.Z., p. 9. *Mamestra insignis* Meyr., Trans. N.Z. Inst., 20, p. 45; Fereday, List N.Z. Lep.; Trans. N.Z. Inst., 30, p. 333. *Melanchra insignis* Hudson, N.Z. Moths and Butterflies, p. 16, pl. 4, figs. 29, 30; Philpott, Cat. Southland Lep., Trans. N.Z. Inst., 33, p. 169.

This moth can be taken around Wanganui at "sugar" in great abundance. It is also attracted by light, and is very common about houses and street-lamps during the summer.

Ovum. Plate I, fig. 8.

Class.—Upright.

Shape.—As seen from above, circular. Transverse section: Bottom flat; sides extending outwards, downwards, and inwards. Top half of egg slightly pointed; extreme top flattened.

Dimensions.—Diameter (at equator), 0·65 mm.; height, 0·42 mm.

Sculpture.—Strong. Strong reticulations or ribs radiate from the micropyle, and diverge towards the equator, converging below. About one in three of these ribs coalesce with another slightly above the shoulder of the egg, but there is irregularity in this respect. There are about forty-one ribs in all, of which about fifteen meet the micropylar cap. The ribs are intersected at right angles by finer reticulations, forming well-defined almost square cells, which under a high power seem to be modified hexagons. The distance between the ribs at the equator is 0·05 mm.

Micropyle.—Consists of a small cell within a rosette of nine, sometimes ten, large elongated cells. The rosette is slightly raised, the elongated cells forming the sides of the elevation; at the top is the micropyle, but sunk crater-like. A band of elongated cells, slightly larger than those forming the rosette, surround the micropylar elevation, and from these cells the main ribs on the egg originate. Measurements are: Micropyle, 0·01 mm.; rosette or micropylar elevation, 0·08 mm. diameter.

Shell.—Fairly strong; shiny; transparent; slightly roughened within cells.

Colour.—When fresh laid, pale green. On the second day the top half of the egg is a light brown except for a large irregular area to one side of the micropyle, and not including it, of the original light green. The under half of the egg remains light green till just before hatching. The brown gradually intensifies, and small dark-coloured spots are scattered over its surface. The irregular green area mentioned above gets smaller as the brown encroaches upon it, and finally splits up into two and sometimes three very small areas. A few days before hatching the light-green areas remaining and on the under half of the egg turn light brown, and the larva can be clearly seen. The whole egg now becomes very dark in colour.

Note.—Well attached to food plant and to each other, though most often the eggs are laid in large spread-out batches in which they do not touch each other. The batch described consisted of 109 eggs. The larvae emerge through the side of the shell, and make their first meal off it. Laid, 13th November; hatched, 24th November = eleven days.

(Described, 13th November, 1912.)

Melanchra composita Guén.

Cloantha composita Guén., Noct., 6, p. 114. *Mamestra composita* Meyr., Trans. N.Z. Inst., 19, p. 22; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 334. *Melanchra composita* Hudson, N.Z. Moths and Butterflies, p. 22, pl. 5, figs. 8, 9.

This moth is very common throughout the year in the Wanganui district.

Ovum. Plate II, fig. 2.

Class.—Upright.

Shape.—Seen from above, circular. Longitudinally oval. Micropylar end slightly larger than its nadir. Sides somewhat compressed.

Dimensions.—Height, about 0·70 mm.; diameter at micropylar end, 0·58 mm.

Sculpture.—Extremely fine. Minute reticulations form a network of irregular four-, five-, and six-sided cells of about 0·02 mm. diameter. Cells surrounding micropyle lengthened in direction radial from the micropyle. Reticulations very hard to distinguish, even under high powers.

Micropyle.—Situated in rosette of elongated pear-shaped cells. Diameter of rosette, about 0·10 mm. Bands of four- and five-sided cells surround the rosette; they are rather elongated, and merge into the common network. Micropyle very indistinct.

Shell.—Fairly strong; transparent; highly glossy; smooth within cells.

Colour.—When fresh laid, creamy white, changing in a day or two to a distinct cream colour. Later the egg assumes a pink tint, and just before hatching turns a slate-blue, while the larva is plainly seen. Infertile eggs turn a light yellow, and collapse.

Note.—Laid in small batches in rows in crevices of box, one row above another. The eggs get very dented soon after being laid; in some cases the dents extend from the micropyle to the base, and give the egg a very strongly longitudinally ribbed appearance. Very strongly attached to each other, and to the box but slightly. Batches of twenty-eight and fifty-five eggs obtained. Laid in October and November. Period of incubation, about seventeen days. The larva eats its way through the micropylar end, and in some cases makes its first meal off the empty shell.

(Described, 2nd October, 1912.)

Melanchra dotata Walk.

Dasypolia dotata Walk., Cat. Lep. Brit. Mus., 11, p. 522; Butl., Cat. Lep. N.Z., p. 8. *Mamestra dotata* Meyr., Trans. N.Z. Inst., 19, p. 24; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 334. *Melanchra dotata* Hudson, N.Z. Moths and Butterflies, p. 24, pl. 5, fig. 16.

I have only succeeded in obtaining three specimens of this moth, and have reason to believe that it is rare around Wanganui. Mr. Hudson records two specimens as having been caught.

Ovum. Plate I, fig. 1.

Class.—Upright.

Shape.—Semispherical; base flat; top flattened slightly.

Dimensions.—Height, 0·54 mm.; greatest diameter, 0·82 mm.

Sculpture.—Strong. Similar to that of *M. insignis.* The following are the chief distinctions: Longitudinal ribs very pronounced, forty-one in number. The shell is broken up by transverse reticulations into fairly deep quadrilateral cells. A network of pentagonal and hexagonal cells surrounds the micropyle.

Micropyle.—Situated in a rosette of six elongated cells. Rosette about 0·04 mm. diameter, and surrounded by the network of cells mentioned above.

Shell.—Very fragile; transparent; shiny; slightly roughened within cells.

Colour.—Very pale green. In about a week a small brown spot is discernible on either side of the micropyle; later more such spots appear, also large irregular areas of darker green. Two days after this a number of small black spots surround the micropyle, while a larger reddish-brown

area appears to one side of it. The hairs of the larva are first to be seen, and later the larva itself is plainly distinguishable. Infertile eggs turn a slightly darker shade of green, and in a week or so collapse.

Note.—Laid in large flat bunches in irregular rows. Batches of 92 and 140 eggs obtained. Strongly attached to box and slightly to each other. Laid, 15th September; hatched, 30th September = fifteen days. The larva emerges through the top of the egg, and makes its first meal off the shell.

(Described, 15th September, 1912.)

Orthosia immunis Walk.

Taeniocampa immunis Walk., Noct., 430. *Cerastis innocua, ib.*, 1710. *Agrotis acetina* Feld., Reise Nov., pl. cix, fig. 6. *Orthosia immunis* Meyr., Trans. N.Z. Inst., 19, p. 30; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 335; Hudson, N.Z. Moths and Butterflies, p. 7, pl. 5, fig. 29.

Fairly common. To be taken in great numbers at "sugar" and on street-lamps.

Ovum.

Class.—Upright.

Shape.—Transverse section circular (as a rule). Vertical section: Base flat; sides bulging outwards and curving in towards the top; top flattened Diameter of top, 0·23 mm.

Dimensions.—Diameter, 0·65–0·70 mm.; height, 0·47–0·55 mm.

Sculpture.—Strong. High reticulations or ribs radiate from the micropylar cap to the equator, converging below. About one in two of the ribs coalesce with another a little above the shoulder of the egg, and there is irregularity in this respect; in more than one instance three ribs coalesce. Thirteen to seventeen ribs meet the micropylar cap. There are from thirty-one to thirty-seven ribs in all. Between the ribs equidistant finer reticulations form quadrilateral cells about twice to three times as broad as long, measurements being—width, 0·05–0·06 mm.; length, about 0·02 mm. Height of longitudinal ribs, 0·01–0·03 mm.; distance apart at equator, 0·05–0·06 mm. Base heavily wrinkled, but not sculptured.

Micropyle.—A deep moat surrounds a correspondingly high eruption which bears the micropyle, crater-like. The micropyle is a deep circular cell 0·01 mm. diameter. The eruption is ribbed longitudinally with fine reticulations forming a rosette of thirteen elongated cells surrounding the micropyle; from these the main ribs or reticulations of the egg originate. The floor of the moat is composed of a band of eighteen hexagonal cells, 0·045 mm. long by 0·02 mm. wide, lengthened in a direction radial from the micropyle. Depth of moat or height of eruption, 0·04 mm.; diameter of eruption, 0·07 mm.; width of moat, about 0·05 mm.

Shell.—Very strong; transparent; shiny; roughened, and slightly wrinkled between reticulations.

Colour.—When fresh laid, white. The second day there is a slight cream tint, changing later to light yellow. On the fourth day the upper half of the egg is lightly mottled with very light brown. On the fifth day there is a distinct broad light-brown band surrounding the egg just above the equator, and a large irregular brown patch covers the micropylar area. The brown coloration now greatly intensifies in shade, the micropylar area being slightly lighter in colour than the equatorial belt. The day before hatching all the light colouring on the shell between the brown areas turns

black, the brown areas get very dark, while the reticulations show up white and sharp, and the larva can be plainly distinguished within the egg. In most cases the brown equatorial belt is broken by a small arm of light yellow joining the top and bottom yellow areas, and sometimes the brown micropylar area extends one or more arms of brown joining it to the equatorial belt. Infertile eggs remain a creamy tint, and quickly collapse.

Note.—Laid in crevices in large uneven batches of sixty eggs or more. Well attached to object, but slightly, if at all, to each other. Batches of sixty and seventy-eight eggs obtained. 115 and 302 eggs obtained from one moth. Laid in November. Period of incubation, eleven days. The larva emerges through the top of the egg to one side of the micropyle, and makes its first meal off the empty shell, sometimes giving its neighbours a help too.

(Described, 17th November, 1912.)

Bityla defigurata Walk.

Xylina defigurata Walk., Cat. Lep. Brit. Mus., 33, Supp., p. 756. *Bityla thoracica, ib.*, p. 869; Butl., Cat. Lep. N.Z., p. 10. *B. defigurata* Meyr., Trans. N.Z. Inst., 19, p. 31; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 335; Hudson, N.Z. Moths and Butterflies, p. 29, pl. 5, fig. 33.

Fairly common. Can be taken in great numbers at "sugar."

Ovum.

Class.—Upright.

Shape.—Spherical; sides much bulged; top slightly flattened. Many eggs, owing to pressure from their neighbours while still soft, are somewhat forced out of their true circular form.

Dimensions.—Diameter, 0·61 mm.; height, 0·51 mm.

Sculpture.—Strong corrugations or ribs radiate from the micropylar area to the equator, converging below. About one in two of the ribs coalesce with another midway between the equator and the micropyle. There are from thirty-three to thirty-six ribs in all, about seventeen of which reach the micropylar area. Between the ribs finer equidistant reticulations apparently form quadrilateral cells, but examined with a high power it is found that they are really modified hexagons with strong longitudinal sides. These transverse reticulations are about 0·02 mm. apart. The longitudinal ribs are about 0·04 mm. apart at the equator.

Micropyle.—Situated in a rosette of twelve elongated cells, which is surrounded by a band of hexagonal cells, longer than broad, lengthened in a direction radial from the micropyle, very irregular in size, and about sixteen to eighteen in number. The micropyle is depressed crater-like within the rosette, which is raised slightly. Diameter of micropyle, 0·005 mm.; diameter of rosette, 0·06 mm.; length of hexagonal cells surrounding the rosette, 0·03 mm.; width, about 0·02 mm.

Shell.—Strong; transparent; shiny; very slightly roughened within cells when viewed with a high power.

Colour.—When fresh laid, pale creamy-white. In a few days a light-brown ring appears on the upper surface of the egg just above the equator, and an irregular area of light brown covers the micropylar cap. The light brown intensifies to a beautiful rich russet-brown, and at the same time encroaches more upon the egg. The greater part of the brown area at the

micropylar cap is to one side of the micropyle itself, and in some cases connects with the brown equatorial belt. The day before hatching the whole of the egg is marbled with different shades of brown, and the larva can be seen making slight movements within the egg, its black hairs being very conspicuous. Infertile eggs turn a light pink, and collapse.

Note.—Laid in batches in neat and regular rows. Well attached to food plant, and slightly to each other. Laid in December. Period of incubation is about nine days. The larva makes its first meal off the empty egg-shell.

(Described, 13th December, 1912.)

Plusia chalcites Esp.

Plusia eriosoma Dbld., Dieff. N.Z., p. 285; Butl., Cat. Lep. N.Z., p. 9, tab. 3, figs. 1, 2; Meyr., Trans. N.Z. Inst., 19, p. 36; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 336. *P. chalcites* Hudson, N.Z. Moths and Butterflies, p. 35, pl. 6, fig. 3.

This beautiful moth is very common in Wanganui throughout the summer, and may often be caught hovering over the garden-flowers in the hot sunshine. The larva has become a regular pest to the flower-gardener. The parent moth lays its eggs on the buds of certain large flowers, such as dahlias, sunflowers, asters, and the like. The young larva burrows into and feeds on the heart of the flower, and when finished with one betakes itself to another, in this way spoiling many a large, seemingly perfect bloom, but which on closer examination bears a huge caterpillar snugly coiled up in its very heart. The pupa is encased in a light silken cocoon sandwiched between two or more leaves.

Ovum. Plate I, fig. 10.

Class.—Upright.

Shape.—A flattened sphere, wider at equator than in vertical section. Base flat; top flattened; micropyle raised.

Dimensions.—Height, 0·33 mm.; diameter, 0·63 mm.

Sculpture. — Strong corrugations or ribs radiate from the micropyle towards the equator, converging below. About two in three of the ribs coalesce with another a little above the shoulder of the egg, but there is irregularity in this respect. About thirteen main ribs reach the micropylar area, and there are about forty ribs in all; these are about 0·02 mm. apart at the equator. Between the ribs finer equidistant reticulations form almost square cells, fairly deep.

Micropyle.—Consists of a small circular cell in midst of a rosette of seven elongated, pear-shaped cells. The rosette is surrounded by two bands or belts of hexagonal cells. The walls of these form the origin of the main ribs.

Shell.—Very fragile; transparent; shiny; smooth within cells.

Colour.—When fresh laid, a pale cream, which, if anything, gets slightly lighter. The larva can be seen within the shell before hatching. Infertile eggs quickly collapse.

Note.—Laid singly. Are well attached to food plant, and in most cases cannot be removed without breakage. Laid in May, and even as early as March. Period of incubation, about a month. The larva emerges at micropylar end.

(Described, 20th May, 1912.)

Rhapsa scotosialis Walk.

Herminia lilacina Butl., Proc. Zool. Soc. Lond., 1877, p. 388, pl. xlii, fig. 11. *Rhapsa scotosialis* Walk., Cat. Lep. Brit. Mus., 34, Supp., p. 1150; Butl., Cat. Lep. N.Z., p. 10; Meyr., Trans. N.Z. Inst., 19, p. 38; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 337; Hudson, N.Z. Moths and Butterflies, p. 36, pl. 6, figs. 5, 6.

This little moth is extremely common about Wanganui throughout the year.

Ovum. Plate I, fig. 12.

Class.—Upright.

Shape.—Transverse section circular. Longitudinal section: Base flat; sides bulging outwards just above the base and then converging at an angle of 45 degrees, making the upper surface of the egg conical in shape.

Dimensions.—Height, 0·49 mm.; greatest diameter, 0·75–0·77 mm.

Sculpture.—The shell is covered with minute white elevations 0·005 mm. diameter, joined by slender reticulations, forming extremely shallow regular hexagonal cells 0·01 mm. diameter. Base smooth.

Micropyle.—Consists of a star-shaped cell surrounded by a rosette of twelve elongated cells. The small white elevations before referred to surround the outer margin of the rosette.

Shell.—Strong; transparent; shiny; slightly roughened or velvety surface.

Colour.—Very light green turning to a steel-grey, and later to a slaty colour. In about a week the colour is light yellow, and soon after the egg is marbled with reddish-brown markings. A few days before hatching the larva can be seen within the egg quite plainly. Infertile eggs turn a light blue, and collapse.

Note.—Laid singly. Well attached to object. The micropylar end collapses about a week after the egg is laid, forming a deep depression in the top of the egg. Batches of eggs obtained in April, July, September, October, November, and December. Period of incubation, about three weeks. The larva emerges at micropylar end of egg, and sometimes makes a meal off the shell.

(Described, 29th April, 1912.)

Euchoeca rubropunctaria Dbld.

Ptychopoda rubropunctaria Dbld., Dieff. N.Z., 2, p. 287. *Hippolyte rubropunctaria* Meyr., Trans. N.Z. Inst., 16, p. 60; *ib.*, 17, p. 63. *Epicyme rubropunctaria* Meyr., *ib.*, 18, p. 184; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 338. *Euchoeca rubropunctaria* Hudson, N.Z. Moths and Butterflies, p. 51, pl. 6, fig. 35.

This pretty little moth is scarce in the Wanganui district.

Ovum.

Class.—Flat.

Shape.—Wafer-like. Longitudinal section oval; micropylar end flattened, broader than its nadir. Transverse section oval; top and bottom much flattened; micropylar end higher than its nadir.

Dimensions.—Length, 0·56–0·58 mm.; width, 0·37 mm. (at micropylar end); height, 0·33 mm. when laid, and a week or so later about 0·28 mm.

Sculpture.—Coarse. Reticulations forming fairly regular hexagonal cells about 0·04 mm. diameter arranged in irregular rows from end to end of egg.

Micropyle.—Situated within a large cell. Slightly raised. Total diameter, 0·05 mm. Very indistinct.

Shell.—Strong; transparent; shiny; roughened within cells.

Colour.—Yellow. Small orange areas appear on the shell in five or six days, and gradually turn to bright reddish-orange. A small black spot appears at micropylar end a day or so previous to the hatching of the egg. The larva can be seen within the egg just before hatching.

Note.—Laid singly. Hardly, if at all, attached to object. The egg soon gets a very dented appearance after being laid, and the top surface collapses, forming a deep oval depression in the egg. Laid in September. Seventeen eggs obtained. Period of incubation, about sixteen days. The larva emerges at micropylar end.

(Described, 20th September, 1912.)

Asaphodes megaspilata Walk.

Larentia megaspilata Walk., Cat. Lep. Brit. Mus., 24, p. 1198; Butl., Cat. Lep. N.Z., p. 14; *ib.*, Cist. Ent., 2, p. 502. *Harpalyce megaspilata* Meyr., Trans. N.Z. Inst., 16, p. 63. *Probolaea megaspilata* Walk.: Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 338. *Asaphodes megaspilata* Walk., Hudson's N.Z. Moths and Butterflies, p. 55, pl. 7, figs. 17, 18, 19, 19A, 20; Quail, Trans. N.Z. Inst., 34, p. 235.

This little species is frequently met with in Wanganui during the summer, and is easily obtained during the daytime by beating thick bushes and creepers.

Ovum. Plate II, fig. 3.

Class.—Flat.

Shape.—Viewed from above, oval; micropylar end slightly flattened and a little broader than its nadir. Transverse section: Micropylar end higher than its nadir, which is well rounded; top and bottom flattened.

Dimensions.—Length, 0·58–0·61 mm.; width, 0·44–0·47 mm.; height, 0·37–0·42 mm.

Sculpture. — Strong. Shell covered with a network of fairly regular shallow hexagonal cells, deepest in the centre. Cells about 0·04 mm. diameter. The reticulations are surmounted by numbers of very minute elevations or pimples. These elevations are most numerous at the micropylar end, and do not confine themselves to the reticulations, but are to be found on the floor of the cells also.

Micropyle.—Consists of a rosette of six small cells surrounded by a band of irregular cells somewhat lengthened in a direction radial from the micropyle. Rosette slightly elevated, 0·06 mm. diameter, and slightly darker in colour than rest of egg. The cells immediately surrounding the micropyle are smaller than on other parts of the egg.

Shell.—Strong; transparent; glossy; slightly roughened within cells.

Colour.—When fresh laid, white, sometimes with a very faint green tinge. In about four days the base of the egg changes to reddish-brown and later to a terra-cotta, shading off towards the micropylar end, which turns a light yellow. Four days before hatching a small black area appears

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at the micropylar end, and shortly after the egg gets mottled and striped with black. At this stage the larva can be seen making slight movements within the shell. Infertile eggs turn yellow, and collapse.

Note.—Laid singly in crannies. Well attached to object. Fifty-one and forty-three eggs obtained from different moths. Laid in October, November, and December. Period of incubation, about thirteen days. Larva emerge micropylar end.

(Described, 15th October, 1912.)

Venusia verriculata Feld.

Cidaria verriculata Feld., Reise der Nov., 5, pl. cxxxi, fig. 20. *Phibalapteryx verriculata* Butl., Proc. Zool. Soc. Lond., 1877, p. 396. *Panopoea verriculata* Meyr., Trans. N.Z. Inst., 16, p. 62. *Paneyma verriculata* Fereday, List. N.Z. Lep., Trans. N.Z. Inst., 30, p. 338. *Venusia verriculata* Hudson, N.Z. Moths and Butterflies, p. 53, pl. 6, figs. 30, 31.

This beautiful species is very plentiful at Wanganui.

Ovum.

Class.—Flat.

Shape.—Oval. Much flattened on top and bottom surfaces, though slightly convex; sides much bulged. Micropylar end slightly broader than its nadir.

Dimensions.—Length, 0·75 - 0·79 mm.; width, 0·58 mm.; height, 0·44 mm.

Sculpture.—The reticulations form a network of irregular hexagonal and pentagonal cells about 0·04 mm. diameter, but around the micropyle the sculpturing is very confused and indistinct.

Micropyle.—Situated in a rosette of about ten elongated cells; surrounded by a band of small hexagonal cells. Diameter of rosette, about 0·08 mm.

Shell.—Strong; shiny; transparent; larva plainly seen a day or so before hatching.

Colour.—Bright green when first laid. In a few days they change to a red-brown with green areas, which later resolves into large irregular areas of red-brown and green. The margins of the areas are quite distinct, the colours not blending into each other. The red-brown areas now gradually increase in size, and get a brilliant red. A day or so before hatching a large brown area (the caput) appears at the micropylar end, and soon splits up into seven small brown areas; the red colouring collects at the base, leaving the rest of the egg a brownish-red. This egg makes a most beautiful object for the low-power microscope.

Note.—Laid end to end in batches in neat parallel rows. The numbers of eggs in different batches differ greatly, some moths laying all their eggs in one batch, others in several small batches, and others again lay their eggs singly. Two hundred eggs were obtained from one moth. The eggs are firmly cemented to food plant, but not to each other. In about a week after being laid the top of the egg collapses a great deal, forming fairly deep oval depressions. Laid in April and October. Period of incubation, about fifteen days.

(Described, 21st April, 1912.)

Elvia glaucata Walk.

Elvia glaucata Walk., *l.c.*, p. 1431 ; Butl., Cat. Lep. N.Z., p. 18, and Cist. Ent., 2, p. 509 ; Meyr., Trans. N.Z. Inst., 16, p. 65 ; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 339 ; Hudson, N.Z. Moths and Butterflies, p. 46, pl. 6, figs. 23, 24.

I have only taken four specimens of this moth in Wanganui this summer.

Ovum.

Class.—Flat.

Shape.—Oval. Micropylar end broader than its nadir, and slightly flattened. Top and bottom somewhat compressed, but their surfaces slightly convex.

Dimensions.—Length, 0·54–0·58 mm. ; width, 0·42–0·40 mm. ; height, 0·35 mm.

Sculpture.—Delicate. Fine reticulations form a network of five- and six- and occasional seven-sided cells, though mostly regular hexagons about 0·03 mm. diameter. Sculpturing at micropylar end roughened, blurred, and indistinct.

Micropyle.—A small slightly raised circular cell in midst of rosette of seven elongated cells. Darker in colour than rest of egg. Inner reticulations of rosette very indistinct. Total diameter, about 0·04 mm.

Shell.—Strong ; shiny ; transparent ; smooth within cells.

Colour.—Pearly white, changing in a day or two to light yellow, and later to a bright yellow. A few days before hatching it turns a light grey, which darkens to a mud-colour. The larva is now plainly seen.

Note.—Laid singly, at intervals of a day or so. Strongly attached to object. Laid from September to October. Period of incubation, eight days. The larva emerges at micropylar end.

(Described, 27th September, 1912.)

Tatosoma timora Meyr.

Tatosoma agrionata Meyr., Trans. N.Z. Inst., 16, p. 68. *T. timora* Meyr., Trans. N.Z. Inst., 17, p. 64 ; Fereday, Trans. N.Z. Inst., 30, p. 340 ; Hudson, N.Z. Moths and Butterflies, p. 40, pl. vi, figs. 28, 29.

Very plentiful in Wanganui at times.

Ovum.

Class.—Flat.

Shape.—As viewed from above, oval ; micropylar end flattened, and broader than its nadir, which in some cases is also slightly flattened. Transverse section oval ; top and bottom much flattened.

Dimensions.—Width, 0·49 mm. (at micropylar end) ; length, 0·63 mm. ; height, 0·35 mm.

Sculpture.—Strong. Reticulations forming a network of irregular pentagonal and hexagonal cells about 0·02 mm. diameter.

Micropyle.—Situated in a broad, saucer-like depression about 0·22 mm. diameter. The micropyle consists of a minute circular cell within a rosette of about eight elongated cells. Diameter of rosette, about 0·08 mm. The whole is very indistinct.

Shell.—Fairly strong; shiny; transparent; very slightly roughened within cells.

Colour.—When fresh laid, yellow. In four or five days darker orange-coloured areas appear here and there on the shell, and later a black area (the caput) appears at micropylar end. The larva can be plainly seen.

Note.—Laid singly. Strongly attached to food plant—in fact, the eggs can hardly be removed without breakage. A few days after being laid the top of the egg collapses a great deal, and the whole egg assumes a very dented appearance. Forty-three eggs obtained from one moth. Laid, 21st September; hatched, 5th October = fourteen days. The larva emerges at micropylar end.

(Described, 21st September, 1912.)

Xanthorhoe rosearia Dbld.

Cidaria rosearia Dbld., Dieff. N.Z., 2, p. 285. *Epyaxa rosearia* Meyr., Trans. N.Z. Inst., 16, p. 71. See also Hudson's N.Z. Moths and Butterflies, p. 57, pl. 7, figs. 22, 23; Fereday's List N.Z. Lep., Trans. N.Z. Inst., 30, p. 340 (*Epyaxa rosearia*).

This little moth has been rare in Wanganui this year, but is generally common, and greatly attracted by light.

Ovum. Plate II, fig. 9.

Class.—Flat.

Shape.—Longitudinal section oval; sides almost parallel. The micropylar end is greater in height than its nadir. Top and bottom are flattened, though at the micropylar end a cross-section is almost circular, and at the base oval. Micropylar end flattened.

Dimensions.—Length, 0·58 mm.; height (at micropyle) 0·37 mm., (at base) 0·26 mm.; width, 0·37 mm.

Sculpture.—Reticulations fine, forming a network of shallow hexagonal and pentagonal cells over whole surface of egg. Diameter of cells, about 0·02 mm.

Micropyle.—A small circular cell about 0·01 mm. diameter enclosed in a rosette of elongated cells. The rosette is encircled by a band of cells longer than broad, lengthened in a direction radial from the micropyle, often four-sided, though sometimes five. These cells are about 0·02 mm. long by 0·005 mm. wide.

Shell.—Strong; shiny; transparent; smooth within cells.

Colour.—Very pale cream, turning to light yellow, and later to a brilliant orange tint.

Note.—Laid singly, and well attached to the object upon which they are laid. The egg becomes somewhat dented after a week or two. Laid in June and hatched in July.

(Described, 14th June, 1912.)

Xanthorhoe cinerearia Dbld.

Cidaria (?) *cinerearia* Dbld., Dieff. N.Z., 2, p. 286. *Larentia cinerearia* Meyr., Trans. N.Z. Inst., 16, p. 83; 17, p. 64. See also Hudson's N.Z. Moths and Butterflies, p. 67, pl. 8, figs. 2, 2A; Fereday's List N.Z. Lep., Trans. N.Z. Inst., 30, p. 343 (*Larentia cinerearia*).

This little moth is very common at Wanganui during the early summer.

Ovum. Plate I, fig. 5.

Class.—Flat.

Shape.—Longitudinally oval; micropylar end much broader than its nadir, and slightly flattened. Transverse section oval, top and bottom flattened, and collapse a good deal as the embryo develops.

Dimensions.—Width, 0·35–0·37 mm.; length, 0·49–0·53 mm.; height, 0·28 mm.

Sculpture.—Strong. Surface broken up into shallow hexagonal and pentagonal cells 0·02–0·03 mm. diameter.

Micropyle.—Micropylar platform flat, about 0·10 mm. Micropyle situated in the centre of a rosette of eight very finely reticulated cells, surrounded by a band of almost circular cells twelve in number and about half the size of the cells forming the sculpture of the egg. Diameter of rosette, 0·04 mm.

Shell.—Fairly strong; transparent; shiny; slightly roughened within cells.

Colour.—When fresh laid, pearly white, changing in a few days to a bright yellow. A day or so before hatching the egg turns a dirty mottled grey, and the hairs of the larva can be clearly seen.

Note.—The eggs were laid singly and in small batches of from three to five on the sides and projecting fibres of the box. Are well attached to whatever they are laid on. Thirteen, twenty-five, and thirty-one eggs were obtained from different moths. Laid in October and November. Period of incubation, about fifteen days. Larva emerges from micropylar end.

(Described, 19th November, 1912.)

Notoreas zopyra Meyr.

Pasithea zopyra Meyr., Trans. N.Z. Inst., 16, p. 89. *Notoreas zopyra* Meyr., *ib.*, 18, p. 184; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 344; Hudson, N.Z. Moths and Butterflies, p. 74, pl. 8, figs. 18, 19.

This beautiful species was caught on Mount Egmont, at an elevation of about 3,000 ft. Only the one specimen was seen.

Ovum.

Class.—Flat.

Shape.—Longitudinal section oval; micropylar end slightly broader than its nadir. Transverse section oval.

Dimensions.—Length, 0·63 mm.; width, 0·47–0·44 mm.; height, 0·37 mm.

Sculpture.—Shell covered with a network of fairly regular shallow hexagonal cells, diameter 0·09 mm. Cells largest at micropylar end. Reticulations roughened.

Micropyle.—Reticulations cease within 0·05 mm. of micropyle, which consists of a green oval cell 0·03 mm. by 0·02 mm., and is raised above surrounding shell.

Shell.—Strong; transparent; slightly shiny; roughened within cells. When viewed under a high power it is seen to be covered with very minute pimples, most numerous at base of egg; even the reticulations are studded with these.

Colour.—When fresh laid, light yellow. Infertile eggs turn yellow, and collapse.

Note.—Laid singly. Ten obtained in January. Well attached to object. (Described, 7th January, 1913.)

Selidosema suavis Butl.

Pseudocoremia suavis Butl., Cist. Ent., 2, p. 497. *Pseudocoemia lupinata* Meyr., Trans. N.Z. Inst., 16, p. 98. *Boarmia suavis* Meyr., Trans. N.Z. Inst., 23, p. 101. See Meyr., Trans. N.Z. Inst., 24, p. 216, as to *Selidosema*. Hudson's N.Z. Moths and Butterflies, p. 83, pl. 9, figs. 3, 4; Fereday's List N.Z. Lep., Trans. N.Z. Inst., 30, p. 345.

Very common at Wanganui throughout the early summer.

Ovum. Plate II, fig. 4.

Class.—Flat.

Shape.—Both longitudinally and transversely oval. The micropylar end is slightly flattened, and is at a slight angle to the micropylar axis; it is broader than its nadir. Top and bottom much flattened. Base well rounded.

Dimensions.—Length, 0·75–0·77 mm.; width, 0·54–0·58 mm.; height, 0·47–0·49 mm.

Sculpture.—Both ends of the egg are capped as far as the shoulder with a network of deep fairly regular hexagonal and pentagonal cells. The middle portion of the egg between these caps is ribbed longitudinally with rather coarse parallel reticulations at slightly varying distances from one another. The distance betweeen the shoulders of the egg, or the length of the ribs, is 0·47 mm. This portion of the egg is also ribbed transversely by somewhat finer reticulations, which, with the main ribs, form parallel rows of quadrilateral cells, deep, and twice as long as broad, the longer side being at right angles to the micropylar axis. Viewed under a high power the longitudinal ribs are found to be wavy and not perfectly straight, thus making the cells modified hexagons. The length of these cells is about 0·05 mm., and the width about 0·02 mm. Each angular point of the cells is surmounted by a small white globular knob; these are very minute, and are most plain at the ends of the egg. Just before the hatching of the egg the reticulations become white and very plain.

Micropyle.—Situated in a rosette of six elongated cells, much roughened and very indistinct; diameter, 0·10 mm. The micropyle itself is free of the white elevations before referred to.

Colour.—When laid, dark green, which becomes darker in a few days, and large brown areas appear. The brown inclines to red. In a week or two the egg is covered with a red and brown mottling. Some days before hatching two or more broad bands of purple appear, extending the whole length of the egg. At this time the larva is plainly seen within the egg.

Note.—The eggs are very large for the size of the moth. Batches of sixty-two and eighty-six eggs were obtained inserted in the cracks of the box in irregular heaps. They were slightly attached to the box and to each other. Infertile eggs remain green, and collapse. Ova obtained in April and October, and take about three weeks to hatch. The larvae emerge through the micropylar end, and are extremely active, but do not make their first meal off the empty shell.

(Described, 22nd April, 1912.)

Selidosema fenerata Feld.

Rhyparia fenerata Feld., Reise der Nov., pl. cxxxi, fig. 7. *Zylobara fenerata* Butl., Cist. Ent., 2, p. 498. *Boarmia fenerata* Meyr., Trans. N.Z. Inst., 20, p. 61. *Zylobara fenerata* Meyr., Trans. N.Z. Inst., 16, p. 97. See Meyr., Trans. N.Z. Inst., 24, p. 216, as to *Selidosema.* Hudson, N.Z. Moths and Butterflies, p. 82, pl. 8, figs. 50, 51; Trans. N.Z. Inst., 32, p. 11: Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 345.

This moth is rare in the Wanganui district.

Ovum.

Class.—Flat.

Shape.—As seen from above, oval; greatest diameter nearest micropylar end, which is flattened and not quite at right angles to the longitudinal axis. Micropylar end broader than its nadir, which is well rounded. Transverse section oval; top and bottom flattened.

Dimensions.—Length, 0·72 mm.; greatest width, 0·54 mm.; height, 0·42 mm.

Sculpture. — Strong. Surface of shell covered with deep, irregular hexagonal cells, about 0·06 mm. diameter. In some eggs the cells show a slight arrangement, being either in rows extending the whole length of the egg or in bands traversing the egg at right angles to the longitudinal axis; but in all cases such rows or bands are very irregular. Each angular point of the cells is surmounted by a minute white elevation.

Micropyle. — The shell immediately surrounding the micropyle is depressed, while the micropyle itself, situated in a rosette of elongated cells, is raised. Total diameter, 0·10 mm. Very indistinct. The small white elevations cease at the margin of the rosette.

Shell.—Shiny; strong; transparent; roughened within cells.

Colour.—Dark green. Dark-brownish areas appear in about a week.

Note.—Laid singly. They are but slightly attached to object. Laid in September, and hatch in about three weeks. The eggs get dented slightly soon after being laid.

(Described, 20th September, 1912.)

Selidosema dejectaria Walk.

Boarmia dejectaria Walk., *l.c.*, p. 394; Butl., Cat. Lep. N.Z., p. 12, and Proc. Zool. Soc. Lond., p. 390; Meyr., Trans. N.Z. Inst., 16, p. 100. See Meyr., Trans. N.Z. Inst., 24, p. 216, as to *Selidosema.* Hudson, N.Z. Moths and Butterflies, p. 86, pl. 9, figs. 19–24; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 346.

This beautiful moth is common around Wanganui throughout the summer. Three varieties of it are also common.

Ovum.

Class.—Flat.

Shape.—This egg is very much like a fowl's in shape, but the broadest end (micropylar) has not a regular curve, one side being slightly bulged. A transverse section of the egg is oval; the top and bottom surfaces are slightly flattened.

Dimensions. — Length, 0·82 mm.; height, 0·58 mm.; width, 0·68–0·70 mm.

Sculpture.—The entire surface of the egg is pitted with large shallow hexagonal cells, saucer-like, deepest in the centre, and about 0·01 mm. diameter. Each corner of the cells is surmounted by a white elevation. These elevations are cylindrical in shape, with a flat top ; diameter, 0·01 mm. ; height above reticulations, 0·01 mm. Seen under a high power these elevations seem to have a hollow passage through their centre communicating with the interior of the egg. The top of each elevation is depressed towards the centre.

Micropyle.—I have examined numbers of these eggs, but have failed to find any form of micropyle. Where the micropyle ought to have been was one of the large shallow cells with the white elevations on its angular points, as on the rest of the shell. The question is, Is there, for a fact, a communication with the interior of the egg through the white nodules referred to, and, if so, do these nodules constitute the micropyles ?

Shell.—Very strong ; shiny ; transparent ; within the cells numbers of small wrinkles extend across the whole surface of the cell.

Colour.—When fresh laid, dull heavy green. Viewed under a medium power the floor of the cells seems to have slight cellular markings of darker green, which, as the embryo develops, turn red, giving the egg a reddish mottled appearance. A few days before hatching the green and red mottling is interrupted by large blackish-brown areas, and the larva can be distinctly seen.

Note.—Strongly attached to food plant. Laid singly. Larvae eat their way out at the micropylar end, but otherwise leave the shell untouched. Just before hatching the reticulations on the shell become white and very clear. Eggs were obtained in May, October, November, and April. Laid, 4th October ; hatched, 8th November = thirty-six days : laid, 1st November ; hatched, 25th November = twenty-five days. Between forty and fifty eggs seems the usual number for a moth to lay. On the 12th April I found two freshly laid eggs on the main stem of a pear-tree, about 12 ft. from the ground. They were 2 in. apart, and well cemented to the stem, and were laid on that portion of it where two or three other branches unite with the main stem. The bark of the stem was covered with a green fungoid growth, and the colour of the eggs gave them splendid protection.

(Described, 29th May, 1912.)

Declana floccosa Walk.

Declana floccosa Walk., *l.c.*, 15, p. 1649 ; Meyr., Trans. N.Z. Inst., 16, p. 102 ; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 346 ; Hudson, Trans. N.Z. Inst., 32, p. 12 ; Hudson, N.Z. Moths and Butterflies, p. 96, pl. 10, figs. 39–47.

This pretty moth is very plentiful at Wanganui during the summer. I have come across six varieties.

Ovum. Plate I, fig. 3.

Class.—Upright.

Shape.—Transverse section circular. Longitudinal section ninepin-shaped. Micropylar end has a much greater diameter than its nadir. Micropyle slightly flattened, base well rounded. These eggs look like miniature fowl's eggs standing on their small ends.

Dimensions.—Height, 0·72 mm. ; greatest diameter, 0·61 mm. ; peripheral distance from micropyle to greatest diameter, 0·33 mm.

Sculpture.—The surface of the shell is covered with very fine reticulations, forming five-, six-, and seven-sided cells (extremely shallow). At each corner of the cells the reticulations are surmounted by a small knob. These knobs are not only confined to where the reticulations intersect, but are scattered indiscriminately along the reticulations themselves, excepting immediately around the micropyle; they catch and reflect the light, and make the egg appear to be spangled with minute silvery globules.

Micropyle.—Consists of a five-armed-star shaped cell surrounded by nine elongated shallow cells in the form of a rosette of 0·06 mm. diameter; is of a darker green than rest of egg, and is slightly raised.

Shell.—Very strong; shiny; transparent; roughened within cells.

Colour.—Light green with a bluish tinge, turning in a few days to dark brown, to chocolate, and then to reddish-brown. In some eggs large areas of the original bluish colour remain on the egg till a few days before hatching, the rest of the egg being marbled in reddish-brown and chocolate. In some cases the margins of these areas are well defined, the colours remaining distinct, and not blending into each other. Just before hatching the larvae can be seen within the eggs, their highly coloured markings giving the eggs a very curious brilliantly striped appearance. Infertile eggs remain bluish, and do not go through further colour-changes.

Note.—Laid in rows in small batches, and singly. All eggs have a slight leaning out of the perpendicular, and as the larva emerges by means of a hole eaten through the micropylar end its weight forces the shell over on to its side; all empty shells are found thus, and the eggs might be mistaken for the flat class. The eggs are slightly attached to object and to each other, and when fresh laid have a very distended appearance. Batches of forty-six and thirty eggs obtained in the months of September and January respectively. Incubation takes about a month.

(Described, 12th September, 1912.)

Declana atronivea Walk.

Detunda atronivea Walk., Suppl. 2, 619. *Chlenias* (?) *manxifera* Fereday, Trans. N.Z. Inst., 12, 268, pl. ix, fig. 1. *Detunda atrovinea* Meyr., Trans. N.Z. Inst., 16, p. 101. *Declana atronivea* Hudson, N.Z. Moths and Butterflies, p. 95, pl. 10, figs. 33, 34; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 346, as *Detunda atronivea.*

This beautiful moth is rare in the Wanganui district, but is very common about Mount Egmont and Ruapehu, and in the high bush country of the upper Wanganui River. It is mostly found at an elevation of about 2,000 ft.

Ovum. Plate I, fig. 11.

Class.—Flat.

Shape.—Longitudinal section oval; micropylar end slightly flattened. Transverse section oval; top and bottom flattened.

Dimensions.—Length, 1·10 mm.; width, 0·93 mm.; height, 0·72 mm.

Sculpture.—The shell is covered with small white elevations about 0·01 mm. diameter and 0·015–0·02 mm. apart. These are joined by squat roughened reticulations forming very shallow fairly regular hexagons. The elevations mentioned above appear to be hollow, and to communicate with the interior of the egg.

Micropyle.—Consists of a small circular cell 0·005 mm. diameter, situated in a rosette of about twelve elongated cells. This is surrounded by a band

of hexagonal cells, twice as long as broad, lengthened in a direction radial from the micropyle. The dimensions of these cells are—length, about 0·02 mm.; width, 0·01 mm. Diameter of rosette is 0·05 mm. There is a second band of fairly regular hexagonal cells; diameter, 0·015 mm. These reticulations are extremely fine and minute.

Shell.—Strong; transparent; very rough; has a slight sheen.

Colour.—Dull heavy green, turning in a week to a light blue, and almost entirely covered with small circular purple spots about 0·015 mm. diameter. A few days before hatching the egg is a light mottled-purple colour, and the larva can be plainly seen.

Note.—Laid singly. Well attached to object. Larvae emerge micropylar end. Laid, 3rd January; hatched, 14th January = eleven days.

(Described, 4th January, 1913.)

Drepanodes muriferata Walk.

Gargaphia muriferata Walk., *l.c.*, 16, p. 1635; Butl., Cat. Lep. N.Z. p. 13. *Panagra ephyraria* Walk., *l.c.*, 16, p. 1761. *Drepanodes muriferata* Meyr., Trans. N.Z. Inst., 16, p. 107; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 347; Hudson, N.Z. Moths and Butterflies, p. 91, pl. 10, figs. 7 to 12.

Scarce in Wanganui district this year.

Ovum. Plate II, fig. 7; Plate I, fig. 2.

Class.—Flat.

Shape.—Oval. Micropylar end flattened and slightly broader than its nadir. Top and bottom much flattened.

Dimensions.—Length, 0·72 mm.; width, 0·56 mm.; height, 0·47 mm.

Sculpture.—A network of hexagonal cells covers the egg; very plain at micropylar end, but becoming more and more indistinct as it approaches the base. Cells about 0·04 mm. diameter. Very minute protuberances surmount the reticulations at the points of juncture.

Micropyle.—Situated within a rosette of about nine elongated cells; about 0·06 mm. total diameter. Very indistinct.

Shell.—Strong; transparent; somewhat shiny; roughened.

Colour.—When fresh laid, white with faint greeny-yellow tinge. In two days many of the cells on the egg turn a brilliant red. The number of these red cells increases slightly, and in some cases two or more unite. A large irregular area of red covers the micropyle. The rest of the egg now gets yellowish, and just before hatching all the red areas disappear, leaving the egg banded with broad and indistinct russet-red markings. The larva can now be distinguished.

Note.—Laid singly, sometimes in small bunches or in rows, and inserted in crannies. Well attached to object. Thirty-two eggs obtained. The shell gets slightly dented. Laid, 14th October; hatched, 2nd November = nineteen days.

(Described, 16th October, 1912.)

Mecyna blairdalis Dbld.

Mecyna blairdalis Dbld., Dieff. N.Z., 2, p. 287.

A very common species at Wanganui, and is best taken by sweeping the long grass in the fields during any part of the day.

Ovum. Plate I, fig. 6.

Class.—Flat (?).

Shape.—Oval. Exceedingly scale-like. Top surface slightly convex.

Dimensions.—Width, 0·68 mm.; length, 0·82 mm.; perpendicular height of egg-mass, 0·16 mm.

Sculpture.—Reticulations delicate and extremely fine, but easily distinguishable, forming an irregular network of lozenge-shaped figures (cells), lengthened in a direction parallel to the longitudinal axis of the egg. Cells composed of four, five, and six sides, very irregular in shape, and about 0·04 mm. long by 0·02 mm. wide.

Micropyle.—Not distinguished.

Shell.—Frail; cannot be touched without damage; transparent; shiny varnished appearance; roughened within cells.

Colour.—When fresh laid, white with very pale cream tinge. The second day the embryo can be seen within the egg in the shape of a broad U with the arms curved spirally inwards. On the sixth day two small brown areas, about 0·14 mm. apart, appear at the upper end of the egg. During the next day or two these become black, while two other small light-brown areas appear between and slightly above the former two. The middle portion of the egg assumes a darkened yellowish tinge, and the embryo larva, although very transparent, can be seen within the egg. The first pair of brown areas that appeared were the eyes, the other pair the mandibles of the larva. Infertile eggs turn slightly yellow, and collapse.

Note.—The eggs are laid singly and in small batches. Thirty-five eggs were obtained from one moth. When laid in batches the eggs are placed in neat regular rows, each egg being about two-thirds overlapped by its neighbours. The egg-contents do not reach the outer wall of the ovum, but leave a thin, flat, transparent, slightly serrated margin. Firmly cemented to food plant and to each other, and it is quite impossible to separate them. The eggs obtained were laid on the underside of the lid of the box in which the parent was confined. Portions of this box were stained red, some parts blue, and the rest left unstained. The coloured areas were in every case carefully avoided, the eggs being laid on the light-coloured wood. Just before hatching the reticulations on the egg become white and very plain. The larva eats its way out at the upper and uncovered portion of the egg, but does not eat the empty shell. Laid, 24th November; hatched, 7th December = thirteen days.

(Described, 24th November, 1912.)

Scoparia chimeria Meyr.

Scoparia chimeria Meyr., Trans. N.Z. Inst., 17, p. 84; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 350.

Fairly common during the early summer, and may be beaten in numbers out of the hedges.

Ovum.

Class.—Upright.

Shape.—Somewhat ninepin-shaped. As seen from above, circular; side view long and oval, base well rounded; micropylar end rounded and broader than its nadir.

Dimensions.—Height, about 0·30 mm.; diameter, about 0·47 mm.

Sculpture.—Shell roughened, but not definitely sculptured. In some eggs there is just a slight suspicion of reticulation.

Micropyle.—Very minute. Situated in a rosette of about eight very finely reticulated elongated cells. Diameter of micropyle, about 0·005 mm.; diameter of rosette, 0·03 mm.

Shell.—Strong; transparent; slight sheen; roughened.

Colour.—When laid, white, changing in a few days to a very pale yellow tint.

Note.—Laid singly. Well attached to food plant. Laid in December. The eggs get a very dented appearance in about a week after being laid.

(Described, 7th December, 1912.)

Scoparia cyameuta Meyr.

Xeroscopa cyameuta Meyr., Trans. N.Z. Inst., 17, p. 112.

Fairly common in the Wanganui district during late summer.

Ovum.

Class.—Flat.

Shape.—Longitudinal section oval, ends somewhat pointed, the greatest width being nearer the micropylar end, which is blunter than its nadir. Transverse section oval, top and bottom flattened. Shape not constant.

Dimensions.—Length, 0·61 mm.; width, 0·40 mm.; height, 0·35 mm.

Sculpture.—Shell covered with very fine roughened reticulations, forming fairly regular shallow pentagonal and hexagonal cells about 0·02 mm. diameter. In some cases the reticulations are somewhat obliterated towards the base of the egg.

Micropyle.—Impossible to distinguish clearly owing to the very wrinkled condition of the shell at this end.

Shell.—Fairly strong; transparent; shiny; roughened within cells. Long thin wrinkles almost the whole length of the egg. The top collapses a great deal after being laid a few hours.

Colour.—Fresh laid, very light yellow. In a few days the margin of the egg changes to a light pinkish-red, and four days after the interior of the egg is taken up by a blackish wedge-shaped area, in which the hairs of the larva can be distinguished.

Note.—Fifteen eggs obtained. Laid side by side in small lots and singly. Well cemented to food plant, and cannot be detached without breakage; in some cases the eggs are slightly attached to each other. Infertile eggs turn yellowish, and collapse. Laid, 8th December; hatched, 20th December = twelve days. Larvae emerge by means of a round hole eaten in the micropylar end.

(Described, 9th December, 1912.)

Crambus flexuosellus Dbld.

Crambus flexuosellus Dbld., *l.c.*, p. 289; Butl., Cat. Lep. N.Z., p. 18; Meyr., Trans. N.Z. Inst., 15, p. 28; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 356; Hudson, Man. N.Z. Ent., pl. 12, fig. 5.

Extremely common throughout the year. Can be taken in great numbers by beating manuka scrub.

Ovum. Plate I, fig. 9.

Class.—Flat.

Shape.—Cylindrical; sides slightly bulged; ends flat; top and bottom slightly flattened.

Dimensions.—Length, 0·47–0·51 mm.; width, 0·28–0·35 mm.; height, 0·33–0·35 mm.

Sculpture.—Very pronounced. There are thirteen to fifteen deep longitudinal reticulations or ribs 0·02 mm. high and 0·07–0·08 mm. apart. These are intersected by very fine transverse reticulations about 0·02 mm. apart, cutting the shell up into parallel rows of deep quadrilateral cells four times as broad as long. Under a high power these cells are really modified hexagons with strong longitudinal sides. The base is cut up into a number of deep depressions and correspondingly high irregular elevations.

Micropyle.—Micropylar end depressed. Micropyle situated in a rosette of about six elongated cells, the whole being slightly elevated. Fine reticulations radiate from the rosette to the ends of the main ribs, and are intersected by similar fine reticulations, forming shallow, very irregular cells. Diameter of micropyle, 0·02 mm.; diameter of rosette, 0·10 mm.

Shell.—Strong; transparent; shiny; roughened within reticulations.

Colour.—When laid, the egg is of a pale-cream tinge, turning in a day or two to a very light pink. The eggs recorded were laid on the 3rd November, and between this date and the 8th November, the changes took place. The egg now assumed an orange-pink colour, and on the 10th November was of an even terra-cotta. No further changes took place till the 24th, when one or two small black spots appeared at the micropylar end. On the 27th large almost black areas were seen at this end, and during the next day or so these areas turned quite black, while the rest of the egg lost much of its brilliant colouring. On the 1st October the larva emerged at the micropylar end.

Note.—Laid singly. Seventy-two eggs in all obtained from one moth. Not attached to object or to each other. Many of the eggs were dropped indiscriminately; others were inserted in crevices of the box in which the moth was kept. Period of incubation, about twenty-six to twenty-eight days.

(Described, 6th November, 1912.)

Ctenopseustris obliquana Walk.

Teras obliquana Walk., *l.c.*, 28, p. 302; Butl., Cat. Lep. N.Z., p. 19. *Paedisca obliquana* Meyr., Trans. N.Z. Inst., 15, p. 60. *Ctenopsuestris obliquana* Meyr., Trans. N.Z. Inst., 17, p. 146; Fereday, List N.Z. Lep., Trans. N.Z. Inst., 30, p. 359.

This little moth is extremely common at Wanganui, and I have come across five varieties. Walker describes the same moth in Butler's "Catalogue of New Zealand Lepidoptera" under the names of *Teras obliquana*, *Teras spurcatana*, *Sciaphila transtrigana*, *Sciaphila turbulentana*, *Teras cuneiferana*, and *Teras congestana*.

Ovum.

Class.—Flat (?).

Shape.—Oval in outline. Exceedingly flat and scale-like. Top surface slightly convex.

Dimensions.—Length, 0·86–0·96 mm.; width, 0·65–0·82 mm.; height of egg-mass, 0·12 mm.

Sculpture.—Reticulations exceedingly fine, and in many parts of the egg indistinguishable. A lozenge-shaped reticulation covers the shell, and is composed of four-, five-, and six-sided figures, roughly 0·08 mm. by 0·03 mm., but very irregular in size and shape; lengthened in a direction radial from the micropyle.

Micropyle.—Formed of a rosette of about twelve elongated cells surrounded by a band of other and larger elongated cells of hexagonal formation. Situated towards the upper and uncovered end of the ovum. Diameter of rosette, about 0·065 mm.; diameter of micropyle, about 0·005 mm. (sometimes larger).

Shell.—Flexible; strong; highly transparent; varnished appearance; slightly roughened within reticulations; gets much wrinkled as egg matures.

Colour.—When fresh laid, dull green. In a few days the green colouring seems to be all absorbed by the embryo, which can be plainly seen, leaving the rest of the egg very transparent. Two small black spots now appear at upper end of egg about 1 mm. apart, and later two small brown areas appear between and slightly above these. The head of the larva now appears, the black spots referred to being its eyes and the brown areas the mandibles. Light-yellowish areas appear within the rest of the egg, and the whole larva can be plainly seen. Infertile eggs quickly collapse and dry up.

Note.—Laid in batches of about thirty eggs. The egg-batches look as if they were composed of a glutinous substance resembling drops of gum or varnish. The eggs are laid in neat regular rows, but about two-thirds of each egg is covered by its neighbours, the ovum being so placed in relation to the egg-mass that the micropyle is outwards and not covered by other ova. Strongly cemented to food plant and to each other. As the embryo matures an oval depression appears in the upper surface of the egg. The green egg-contents do not reach the outer wall of the ovum, but leave a thin, flat, transparent, slightly serrated margin. Laid in December. Ninety, sixty-three, and forty-three eggs were obtained from different moths. Period of incubation is about eight days in favourable weather. The eggs were always laid on the blue binding of the boxes in which the moths were kept, and were extremely difficult to distinguish. I have found batches of the eggs on the upper surface of the English ivy leaves, but have never come across the larvae. In almost all such cases the eggs were attacked by parasites. The green colouring of the eggs is naturally one for protection. The larvae emerge from the upper and free end of the egg, and do not eat the egg-shell afterwards.

(Described, 8th December, 1912.)

Phloeopola confusella Walk.

Phloeopola confusella Walk.: Meyr., Proc. Linn. Soc. N.S.W., 1883, p. 354; Meyr., Trans. N.Z. Inst., 43, p. 69.

I have got two or three specimens of this pretty little moth around Wanganui. It seems to be rare elsewhere.

Ovum. Plate I, fig. 4.

Class.—Flat.

Shape.—Longitudinal section oval; micropylar end slightly broader than its nadir. Transverse section circular; micropylar end flattened, base well rounded.

Dimensions.—Length, 0·58 mm.; height, 0·35 mm.; width, 0·35 mm.

Sculpture.—Finely ribbed longitudinally. No transverse reticulations. Ribs almost parallel, 0·05 mm. apart, about twenty-two in number. In some cases two ribs coalesce some distance from the micropylar end, and continue to the micropyle as one.

Micropyle.—Micropylar end flattened and slightly sculptured in very shallow cell formation. Micropyle consists of a small circular cell about 0·015 mm. diameter. Very indistinct.

Shell.—Very strong; slight sheen; transparent; entirely covered with extremely minute pimples when viewed with a high power. At the micropylar end these are larger, though less numerous than on rest of egg, being twice as high as broad; height, 0·015 mm.

Colour.—When fresh laid, light cream tinged with green, changing in about a week to light grey slightly tinged with purple. The purple tint becomes stronger at the micropylar end, shading off towards the base.

Note.—Very well attached to object. Laid singly and in small bunches inserted in cracks and crannies. When laid in lots they are arranged, end to end, in regular rows. Eighty-three eggs obtained. Laid, 9th January; hatched, 28th January = nineteen days. Larvae emerge from micropylar end.

(Described, 10th January, 1913.)

Alucita monospilalis Walk.

Aciptilus monospilalis Walk., *l.c.*, 950. *A. patruelis* Feld., Reise Nov., pl. cxl, 56. *A. monospilalis* Meyr., Trans. N.Z. Inst., 17, p. 124. *Pterophorus monospilalis* Hudson, Trans. N.Z. Inst., 28, p. 379. *Alucita monospilalis* Meyr., Trans. N.Z. Inst., 45, p. 47.

This very beautiful little moth is very common in Wanganui during the summer. It is most common in November, and I have found numbers of the ova, larvae, and pupae on the English ivy during this month. The moth is again very plentiful in January, and still later in April. The larva feeds on the upper surface of the leaf, quite exposed. It is very destructive to the ivy on account of its great numbers and its voracious appetite. The full-fed larvae simply suspend themselves from a silken pad on the underside of a leaf by means of the cremastral hooks on the anal segment; no cocoon or other protection for the pupa is used.

Ovum. Plate II, fig. 8.

Class.—Flat.

Shape.—Extremely wafer-like. Longitudinal section oval; ends well rounded and equal. Transverse section oval; top and bottom flattened or quite flat.

Dimensions.—Length, 0·47–0·49 mm.; width, 0·37–0·38 mm.; height, 0·19–0·23 mm.

Sculpture.—Extremely fine; hardly discernible even under high powers. Very slight cellular structure on shell.

Micropyle.—Small deep circular cell surrounded by four or more similar but shallower cells. Very indistinct. About 0·02 mm. diameter.

Shell.—Very transparent; strong; smooth; highly glossy.

Colour.—Pearly white. Light-yellowish areas appear around the margin of the egg in about a week, and a small brown area (the caput) appears at

micropylar end. In about four days after being laid the embryo can be seen in the shape of a broad U with the arms wound spirally inwards, but as the egg matures this disappears, giving place to light-yellowish areas. Larva plainly seen a few days before hatching.

Note.—Laid singly and in pairs; well attached to underside of leaf of food plant. A day or two after being laid the top of the egg collapses a great deal, forming a large deep oval depression. Twenty-five and fifteen eggs obtained from different moths. Laid in October and January. Period of incubation, about thirteen days. The larva emerges from the micropylar end of the egg.

(Described, 6th October, 1912.)

Index to Genera and Species.

Alucita monospilalis.
Asaphodes megaspilata.
Bityla defigurata.
Crambus flexuocellus.
Ctenopseustis obliquana.
Declana atronivea.
—— floccosa.
Drepanodes muriferata.
Elvia glaucata.
Euchoeca rubropunctaria.
Mecyna blairdalis.
Melanchra composita.
—— dotata.
—— insignis.
—— lignana.
—— mutans.
Notoreas zopyra.
Nyctemera annulata.
Orthosia immunis.
Phloeopola confusella.
Plusia chalcites.
Porina cervinata.
—— characterifera.
—— umbraculata.
Rhapsa scotosialis.
Scoparia chimeria.
—— cyameuta.
Selidosema dejectaria.
—— fenerata.
—— suavis.
Tatosoma timora.
Venusia verriculata.
Xanthorhoe cinerearia.
—— rosearia.

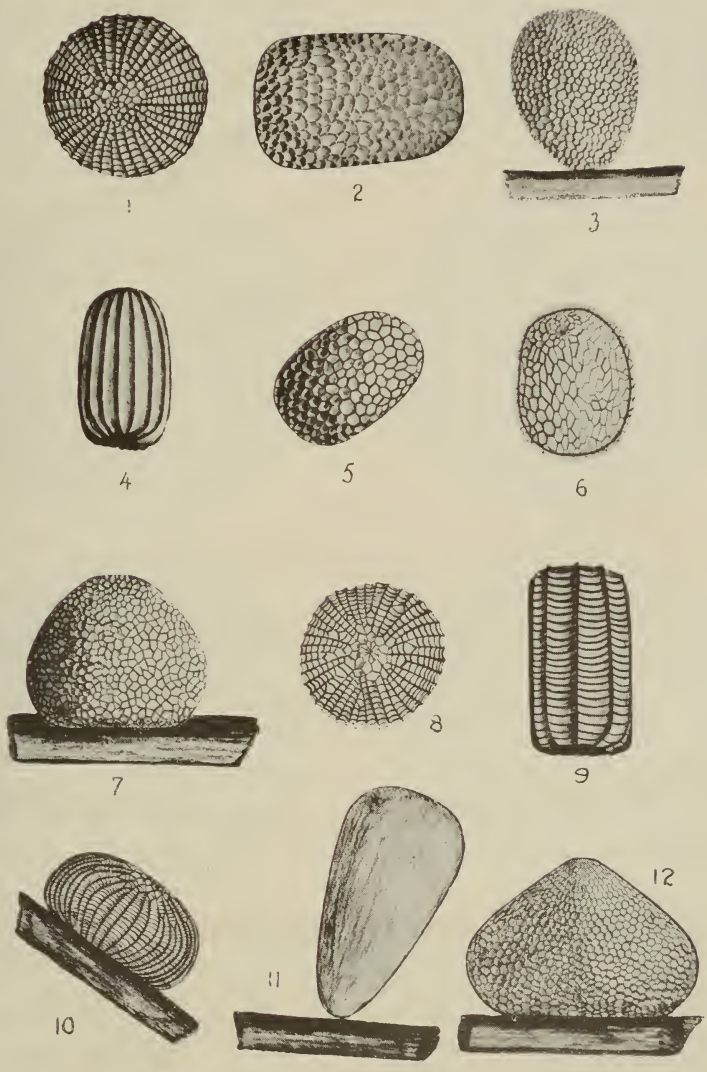
EXPLANATION OF PLATES.

Plate I.

Fig. 1. Ovum of *Melanchra dotata* (as seen from above).
,, 2. ,, *Drepanodes muriferata.*
,, 3. ,, *Declana floccosa* (side view).
,, 4. ,, *Phloeopola confusella* (as seen from above).
,, 5. ,, *Xanthorhoe cineraria.*
,, 6. ,, *Mecyna blairdalis.*
,, 7. ,, *Nyctemera annulata.*
,, 8. ,, *Melanchra insignis.*
,, 9. ,, *Crambus flexuocellus.*
,, 10. ,, *Plusia chalcites.*
,, 11. ,, *Declana atronivea.*
,, 12. ,, *Rhapsa scotosialis.*

Plate II.

Fig. 1. Ova of *Melanchra mutans* (batch).
,, 2. ,, *Melanchra composita.*
,, 3. ,, *Asaphodes megaspilata.*
,, 4. ,, *Selidosema suavis.*
,, 5. ,, *Melanchra mutans.*
,, 6. ,, *Melanchra lignana.*
,, 7. ,, *Drepanodes muriferata* (at end of first week).
,, 8. ,, *Alucita monospilalis.*
,, 9. ,, *Xanthorhoe rosearia.*



Ova of Lepidoptera.

Face p. 94.

Ova of Lepidoptera.

ADDENDA.

Melanchra mutans.

When studying the eggs of this moth I was struck by the dissimilarity of the eggs in some of the batches. This led me to examine the parent moths more closely, and, although they were almost similar to the type specimen, there were slight differences in the size, colouring, and clearness of the markings, and these, combined with the dissimilarities in the eggs, caused me to class the parent moths as two distinct varieties. I examined batches of eggs of eight specimens of variety A, and in all these both the parent moths and individual eggs of different batches were startlingly alike. Of variety B, I only had the good fortune to examine batches from three moths, and the dissimilarities of these and their eggs when compared with the others, and their similarity to one another, led me to class these as another variety.

Variety A.

This moth has a slightly greater wing-expansion than the type specimen. The colouring is brown and grey. The markings, although of the same form as in the type specimen, are much more distinct.

Variety B.

The colour of this moth is a rich reddish-brown. As in variety A, the wing-expansion is slightly greater than in the type specimen, but is not so great as in variety A. The markings are white with black margins, and are beautifully distinct.

ART. XIV.—*New* Lepidoptera.

By W. GEORGE HOWES, F.E.S., F.L.S.

[*Read before the Otago Institute, 4th November, 1913.*]

Leucania hartii n. sp.

♀; 32 mm.; one specimen. Face brown, faintly irrorated with grey. Head grey-brown. Palpi and antennae ochreous brown. Thorax brown, crests absent. Abdomen grey-brown, tufts rufous. Forewings covered with dull silvery (lead-coloured) scales, the rather indistinct lines being bright rufous. Two distinct marks on costa close to base, being portion of a broken indistinct line across wing. At ⅓ there are two other distinct marks on costa, continuing as ill-defined lines across wing. Orbicular and claviform outlined in rufous. Orbicular elongate. A very distinct line crosses between reniform and orbicular, running straight across save for a slight outward bend at wing-centre. Reniform has an ochreous lunate mark in centre, margined by rufous on basal side, and also outwardly, but outwardly is not distinctly defined. Close to termen there are faint traces of a rufous line; a series of slight rufous dots along termen. Cilia light ochreous, with an ochreous line at base. Hindwings ochreous, slightly rufous towards termen. Cilia dull rufous, with an ochreous line at base.

Leucania hartii. (Natural size.)

A single specimen, taken by Mr. S. Hart at the Cape Egmont Lighthouse, 20th March, 1911. Unfortunately, although Mr. Hart has sent me quite a lot of valuable material from this locality, I have not been so fortunate as to secure another specimen of this species.

Ichneutica cana n. sp.

♂; 44 mm.; one specimen. Face grey. Palpi blackish at base. Head and thorax grey, frontal area lighter grey. Head and thorax densely clothed with long dark-grey hair. Thorax broad in proportion to length, with a slight posterior crest. Abdomen grey. Forewings grey, with pale-grey lines and occasional darker marks. A single light-grey line at base; a jagged grey line about $\frac{1}{5}$, strongly dentate near dorsum; outwardly suffused with dark grey. Orbicular faintly shown in light grey, and separated from reniform by a distinct dark-grey patch. Reniform faintly outlined in light grey. A jagged light-grey line at $\frac{3}{4}$, bending towards termen until centre of wing, then inwards before reaching dorsum. Terminal edge margined with light grey, edged basally with a dark suffusion, which forms a faintly defined line; slight grey marks along veins where they reach termen. Cilia short, light grey and dark grey alternate patches. Hindwings light grey with a faint ochreous tinge, a darker band across wing at $\frac{1}{2}$ and a slightly waved subterminal band. Terminal edge and cilia grey-white. Underside grey with a faint ochreous tinge and a well-defined irregular dark-grey line at about $\frac{2}{3}$ across both wings.

Ichneutica cana. (Natural size.)

A single specimen of this fine moth netted in brilliant sunshine on the Hector Mountains, Wakatipu district, 20th November, 1911.

Pseudocoremia maculosa n. sp.

♂; 35 mm. Face fuscous. Head white with fuscous patch behind base of antennae; shafts of antennae fuscous at base, then mixed with white and fuscous to tips; pectinations fuscous. Thorax fuscous anteriorly, then silvery-white with two slight fuscous marks, then a dark-fuscous cross-line followed by another silvery-white area. Abdomen grey-white with a narrow patch of fuscous from apex of each segment, which are posteriorly grey-white. Wings silvery-white, faintly lined and stippled with ferruginous-fuscous, and where lines cross veins at centre of wing sharply marked with black. Basal patch silvery-white sharply edged by a dark-fuscous patch which is outwardly suffused. Indistinct lines at $\frac{1}{6}$ and $\frac{1}{3}$; well-defined lines at $\frac{1}{2}$ and $\frac{2}{3}$, black-marked where they cross the veins. Then follows a white area suffused at centre of wing. Subterminal line waved, suffused outwardly almost to apex, the lower part of the subterminal area stippled with ferruginous-fuscous. A terminal series of black lunules. Cilia (damaged) apparently grey and fuscous-white mixed. Reniform represented by a black streak. Hindwings grey-white faintly stippled with ferruginous-fuscous. Discal spot small and faintly marked. Two faint subterminal lines, termen dark-edged, cilia fuscous-grey.

Pseudocoremia maculosa. (Natural size.)

A single male specimen netted at Queenstown, Wakatipu district, 20th November, 1910. Mr. M. Pasco has another specimen from the same locality.

Close to *Pseudocoremia leucelae* and *P. monacha*, but abundantly distinct.

ART. XV.—*Notes on the Life-history of some New Zealand Moths.*

By W. GEORGE HOWES, F.E.S., F.L.S.

[*Read before the Otago Institute, 4th November, 1913.*]

Morrisonia merope.

Larva taken in the Woodhaugh Gardens, Dunedin, on the 16th March, 1912. A single specimen taken, crawling on the trunk of a ribbonwood-tree (*Plagianthus*).

Length, about 40 mm. ; probably full-fed, being " deep " (about 8 mm.) for its length. The caterpillar was of robust appearance.

General colour, dull olive-green, marked with black. Face with horny plate, marked with small black dots. A dorsal line of ochreous dots of fair size, a series of lateral oblique lines and small dots. Spiracles plainly indicated by black dots. Underside pale ochreous. Prolegs on segments 6, 7, 8, 9, the pair on the last segment well marked with a black patch over rear.

The larva pupated after a few days, probably being slightly hurried by want of suitable food. The moth emerged on the 9th June, 1912. The seven imagos I have taken were taken at " sugar " in December, January, and March, so that the time of emergence of this specimen does not seem quite natural.

Declana egregia.

Larvae taken at Half-moon Bay, Stewart Island, in March, 1913, feeding on *Panax*.

As mentioned in accompanying paper, " Notes on the Entomology of Stewart Island," the larvae were in abundance—so numerous that they had stripped the stems of all foliage, and were reduced to gnawing buds and terminals. The larvae varied considerably in size from full-grown specimens slightly over an inch in length to small fry of about a quarter of an inch. The peculiar shape of the larvae is well described by Mr. Hudson in his description of that of *Declana atronivea ;* in fact, the description is so exact that it answers equally well for *egregia*, the only noticeable point being that the *egregia* caterpillars had all a pink tinge.

The colouring and shape were strongly protective, especially so when the caterpillar held by the anal claspers and stretched its body out from the trunk.

Unfortunately, the caterpillars (most of which were sent to the Dominion Museum) did not survive. I had the good fortune to obtain one fine specimen, which emerged on the 18th March, 1913.

Leucania nullifera.

Larvae generally distributed.

Hudson, in " New Zealand Moths and Butterflies," says the larvae of this moth live in the spear-grass, " a single one in each clump." In several localities I have cut out the clumps of *Aciphylla*, and on each occasion found the caterpillars gregarious. At Riversdale, on the Waimea Plains, one clump had quite a number of individuals feeding within it, and they varied considerably in size. The larger larvae were from 2 in. to 2½ in., while the smaller were from ¾ in. to 1 in. Apparently last year's full-grown caterpillars

were living harmoniously with a later brood. The smaller ones seemed to be in no way molested by their larger brethren. By stepping on the spines it is possible to cut into the clump with a penknife with moderate ease, but no comfort. When the larvae are in possession of a clump the outer spines are matted together with "frass," and the interior root-crown is generally completely eaten out to a depth of a few inches. Collecting on the slopes of Mount Earnslaw, I came upon a clump of spear-grass in which the interior burrow was full of water, but the five full-grown caterpillars inhabiting it did not seem at all inconvenienced, but wallowed round in the mixture of "frass" and water.

Mr. Hudson gives a description of the larvae in his "New Zealand Moths and Butterflies," p. 10.

Leucania purdei.

Various larvae, taken at different times, and generally distributed. The larva is full grown about the end of October, and is then about 48 mm. in length.

General colour, ochreous with a pink flush. A double fuscous line dorsally, a fuscous line from base of eye, marked with deep-fuscous marks at each segment. A fuscous lateral line with distinct black dots at each segment. Prolegs on segments 6 to 9. Pupa enclosed in slight cocoon. Rather slim and long, with a well-developed spine.

Emergences and captures of the moth have occurred from December to March.

This magnificent moth, with its beautiful orange-red colouring, must be commoner than it is usually considered, as the clumps of *Astelia* on which the larvae feed everywhere show traces of the insects' attacks. The caterpillar has a habit of cutting out portions of the leaf and then clinging in the gap formed to feed, when, being of the same shade as the leaves, it is extremely difficult to detect. It is a nocturnal feeder, retreating to the interior of the clump during daylight.

Art. XVI.—*Notes on the Entomology of Stewart Island.*

By W. George Howes, F.E.S., F.L.S.

[*Read before the Otago Institute, 4th November, 1913.*]

The entomology of Stewart Island has so far been almost entirely neglected. The following notes and records of captures should prove of interest, and may lead to more extensive work in this promising and interesting field.

Towards the end of February, 1913, I landed at Stewart Island, intent on working as much ground as possible in the week at my disposal. Unfortunately, weather-conditions were anything but pleasant, and the bush was soaking from a deluge that had been almost unceasing for five weeks. Insect-life had suffered severely; even the ubiquitous sandflies, whose swarming thousands generally extend the warmest of welcomes to the unsuspecting visitor, were reduced to a few dispirited and disheartened individuals.

The evening of my arrival I tried the bush, protecting myself with an oilskin; but the heavy drizzle washed the "sugar" from the trees, and

nothing was attracted. For the remaining evenings of my stay I persisted with the "sugaring" of the trees. Whether rain or fine, the mixture proved quite unattractive save to the usual olla podrida of the commoner beetles, chelifers, cockroaches, *Arachnidae*, &c. The absence of the moths was the more unexplainable as no attractive bush flowers were out. At the township the flowers of *Escallonia* attracted the common *Morrisonia mutans*, *M. plena*, *M. stipata*, and *M. rubescens*, *Leucania atristriga*, *L. semivittata*, *Persectania ewingii*, and *Ariathisa comma*.

Working the bush tracks each evening with net and lamp I was fairly successful, getting the rare *Hydriomena arida* in fair numbers, and a few *Xanthorhoe oraria* and *X. occulta*; also *Chloroclystis muscosata* and *C. lichenodes*, and one or two *Tatosoma agrionata*. *Sestra flexata* flew from the bracken-fronds, while *Xanthorhoe beata* was common enough to be rather a nuisance. *Xanthorhoe aegrota*, *X. semisignata*, *Hydriomena similata*, *Asaphodes rufescens*, and *A. rufescens* var. *falcata*, with one or two *Selidosema dejectaria*, practically complete the list. The fine but common *Rhapsa scotosialis* was present in large numbers. In the micros I found but little of interest, the best being the delicate plume *Pterophorus monospilalis*. A small Tortricite somewhat resembling *Ctenopseustis obliquana* struck me as new, and on reference to Mr. Philpott he informed me that it was undescribed, he having a specimen also. This has since been described as *Tortrix tigris*.

I am indebted to my sister, Miss Edith Howes, for a most interesting find. When hunting for sea-animals on a small rocky islet in Half-moon Bay, she came upon a number of caterpillars. These I found were feeding on a clump of *Panax*, and I had no hesitation in placing them as the larvae of *Declana egregia*. So numerous were the caterpillars of this rare moth that I was able to send dozens of them to the Dominion Museum, in Wellington, to be reared. Unfortunately, no moths have emerged. Having kept one or two caterpillars, I had the pleasure of rearing a single very fine specimen of *Declana egregia*. The number of larvae on the shrub was so great that the green leaves had all been eaten, and the larvae were clinging to the bare stems, gnawing the softer bark and terminal buds. This starvation diet and the long-continued rain explains the non-success in rearing.

On several occasions I attempted to arrange trips to reach the higher levels of Stewart Island, but owing to the bad weather and the difficulty of transit and length of time involved had to abandon the idea. Mount Anglem (3,200 ft.) and Mount Rakeahua (2,200 ft.), with their tops above the bush line, should provide a fine field, full of interesting and novel finds, for some more fortunate collector.

The following notes on the insects collected by Mr. R. Fisher, of Gore, at Ruggedy, on the north-west corner of the island, form a very interesting addition to our knowledge, and deal with a locality not easily attainable to the average collector.

During Easter, 1911, Mr. Fisher was one of a party camped at Ruggedy. Volume 44, Trans. N.Z. Inst., page 76, gives the botanical results of this expedition, the article being by Mr. Poppelwell, of Gore. The accompanying lists show the insect fauna as collected by Mr. Fisher, and great credit is due to him for the number of species taken and the wide range they cover. Mr. Fisher's previous experience in entomological collecting was limited to a single night's "treacling," with myself, at the bush near

Gore. He had very little apparatus, yet handed to me over a hundred specimens, mostly in good condition, for his few days' stay at Ruggedy.

The *Noctuae* are poorly represented, but of the *Geometrae* sixteen species were taken, and of these four are distinctly rare, while one (*Microdes villosata*), so far as I am aware, is only in one other collection in New Zealand—the Buller Collection, in the Dominion Museum. Mr. Fisher, fortunately, took both sexes. The male has a peculiar fold in the centre of the hindwing; this fold, being black on the grey-white wing, makes the moth both curious and noticeable in appearance.

Of the *Micro-lepidoptera* there are fifteen species, *Diptera* three species, *Hymenoptera* three, *Neuroptera* one, *Hemiptera* one, and *Orthoptera* one. Mr. Fisher mentioned that the inclusion of several sandflies was accidental, but unavoidable.

Collection made by Mr. R. Fisher, of Gore, at Ruggedy, about the 17th April, 1911.

Macro-lepidoptera.

Morrisonia mutans.
—— ochthistis.
—— plena.
Rhapsa scotosialis.
Microdes villosata.
Chloroclystis indicataria.
—— plinthina.
Hydriomena deltoidata.
—— similata.
—— arida.
—— subochraria.
Euchoeca rubropunctaria.
Asthena schistaria.
Asaphodes rufescens.
—— —— *var.* falcata.
Xanthorhoe beata.
—— venipuncta.
Notoreas synclinalis.
Selidosema suavis.
Drepanodes muriferata.
Declana junctilinea *var.* crassitibia.
Diptycophora auriscriptella.
Crambus flexuosellus.
—— tuhualis.
—— ramosellus.
Scoparia cyptastis.
—— ustimacula.
—— sabulosella.
Scoparia (?).
Mecyna notata.
Ctenopseustis obliquana.
—— excessana.
Carposina gonosemana.
Strathmopoda skelloni.
Borkhausemia nyctens (?).
Borkhausemia (?).

Diptera.

Apsoma (?).
Two unidentified.

Hymenoptera.

Ichneumon deceptus.
Ichneumon (?).
Salius nitidiventris (?).

Neuroptera.

Xanthagrion zealandicum.

Hemiptera.

Rhopalimorpha similis.

Orthoptera.

Acanthoderus (?).

ART. XVII.—*Descriptions of New Zealand* Lepidoptera.

By E. MEYRICK, B.A., F.R.S.

Communicated by Dr. Charles Chilton.

[*Read before the Philosophical Institute of Canterbury, 3rd December, 1913.*]

I AM indebted to Messrs. G. V. Hudson and A. Philpott for an unusual amount of interesting material this year, and am enabled to describe thirty-seven new species. These include several remarkable new types which one would hardly have expected to escape observation so long, but also some obscure forms which have been with difficulty disentangled after prolonged study. The New Zealand fauna contains an exceptional proportion of these difficult forms, whose slight and elusive differences do not provoke suspicion; whilst, on the other hand, there are very variable species whose forms exhibit much greater apparent diversity.

Attention might be directed to the species of *Nepticula*, neglected on account of their minute size. The larvae mine blotches or galleries in leaves, and are not difficult to find. I took three species in New Zealand, but they have not been noticed by others; there may probably be a dozen.

CARADRINIDAE.

Aletia obsecrata n. sp.

♀. 34 mm. Head and thorax dark grey mixed with white and black. Palpi grey mixed with white and black, second joint hairy, terminal joint rather long. Abdomen grey. Forewings elongate-triangular, costa straight, termen bowed, hardly waved, oblique; dark grey, somewhat mixed with light grey-greenish; an undefined white subbasal line from costa reaching ⅔ across wing, edged posteriorly with blackish; discal space between this and first line indistinctly streaked with brownish; first and second lines waved, whitish, edged with blackish suffusion; median shade curved, blackish, on lower half of wing suffused into margins of first and second lines; orbicular and reniform indistinctly outlined with white irroration; an almost terminal series of spots of white irroration, preceded by blackish suffusion; a terminal series of black semicircular dots separated by whitish irroration: cilia grey with two blackish shades, towards base barred with white irroration. Hindwings grey irrorated with blackish, towards base thinly; cilia whitish, with indistinct greyish subbasal line.

Ben Lomond, 2,000–3,000 ft., not uncommon (Philpott); one specimen. At once recognizable by the unusually dark colouring.

Aletia fibrata Meyr.

This name (Trans. N.Z. Inst., vol. 45, p. 22) is there misprinted *fibriata*.

Aletia sminthistis Hamps.

I have examined the type of this species. It is a large insect allied to *griseipennis*, but considerably darker. I have seen no other specimen.

Aletia sollennis n. sp.

♂. 35 mm. Head and thorax light brownish-ochreous or brownish. Terminal joint of palpi short. Antennae ciliated (1). Forewings elongate-

triangular, costa almost straight, termen rounded, waved, rather oblique; brownish-ochreous, more or less fuscous-tinged; veins obscurely sprinkled with whitish, and posteriorly also with fuscous; margins of reniform faintly indicated with whitish; a curved transverse series of whitish dots on veins at $\frac{3}{4}$, each dot preceded and followed by indistinct dark-fuscous dots: cilia light ochreous sprinkled with whitish. Hindwings fuscous, darker towards termen; cilia ochreous-whitish, basal half suffused with fuscous.

Waipori, in November and January (Philpott); two specimens. Allied to *nullifera*.

This is the species erroneously recorded by me as *Dasygaster hollandiae*, and that name should be struck off the New Zealand list. The specimen originally identified had lost its abdomen, the structure of which is the distinguishing characteristic of *Dasygaster*, but Mr. Philpott kindly forwarded for examination his only other specimen, and this shows that it is not a *Dasygaster* at all. The true *hollandiae* is also (as pointed out to me by Mr. Philpott) a redder insect, without the distinct posterior row of whitish dots; otherwise it is very similar.

Andesia pessota Meyr.

In my revision of the *Caradrinina* (Trans. N.Z. Inst., vol. 44, p. 95) I referred this (of which I had then no example) with considerable doubt to *Hypnotype* Hamps. Mr. Philpott has very kindly sent me a specimen of the species, which enables me to correct this reference: it belongs properly to the genus *Andesia* Hamps. (Cat. 6, 142), and bears considerable superficial resemblance to the single species recorded by Hampson, *A. oenistis*, from Argentina. This is therefore a very interesting identification. The generic diagnosis should be modified to read, "Abdomen with crest on basal segment."

Hydriomenidae.

Chloroclystis maculata Huds.

Mr. Hudson has now very liberally sent me a specimen of this apparently scarce species; it is a true *Chloroclystis*, and very distinct. Antennae of ♀ shortly ciliated; palpi nearly 3.

Xanthorhoe benedicta n. sp.

♂♀. 22–25 mm. Rather smaller than *beata* (26–28 mm.); extremely similar to it, but distinguished by presence of transverse-linear black discal mark in pale space of median band of forewings (in *beata* entirely absent); also by hindwings being faintly greenish-tinged, with whitish cilia finely barred with grey, whilst in *beata* the hindwings have no greenish tinge, and the basal half of cilia is suffused with pale ochreous.

Christchurch, Dunedin, Invercargill; five specimens. This species, which is commoner than *beata*, has hitherto been confused with it by myself and others generally. I am indebted to the acumen of Mr. Philpott for its discrimination; he has endeavoured for three years to convince me of its distinctness, and has at last succeeded.

The four points of distinction mentioned above are constantly present together, and thus prove that the differences are not varietal only. The true *beata* occurs at Lake Wakatipu, Ben Lomond, and Invercargill; it stands midway between *benedicta* and *adonis*. Butler's description and figure, though poor, are sufficient to show which species is intended without doubt.

Notoreas anthracias Meyr.

Mr. Philpott has correctly pointed out to me that this species should be referred to *Notoreas* instead of *Xanthorhoe*.

Dasyuris hexaleuca n. sp.

♀. 18 mm. Head and palpi white mixed with black. Thorax black with a white line on each side of back. Abdomen black sprinkled with white, segmental margins white. Forewings triangular, termen bowed, rather oblique; black; six ochreous-white transverse lines, first cloudy, ill defined, second and third nearly straight, third rather thick, fourth fine, angulated in disc, fifth thick, rather curved outwards in disc, sixth slender, curved, very near termen on lower half; a transverse ochreous-white mark in disc between third and fourth: cilia white barred with dark grey. Hindwings with termen rounded; blackish; basal area irrorated with white; three ochreous-white transverse streaks, first before middle, narrow, somewhat angulated in disc, with a distinct prominence from angle, second at $\frac{2}{3}$, rather broad, bent in disc, third narrow, rather waved, curved, praeterminal: cilia whitish, barred with dark grey on basal half, and with extreme base irregularly dark fuscous.

Ben Lomond, in November; one specimen. Probably a *Dasyuris*, allied to *leucobathra*, but ♂ not seen.

PYRAUSTIDAE.

Scoparia animosa n. sp.

♀. 15 mm. Head brown. Palpi $2\frac{1}{4}$, ochreous-whitish mixed with fuscous, with oblique dark-fuscous band at base of second joint. Thorax ochreous-brown, patagia suffused with dark fuscous. Abdomen pale grey. Forewings very elongate-triangular, termen somewhat rounded, rather oblique; bronzy-brown, with some scattered black scales; dorsal $\frac{2}{3}$ suffused with black from base to first line, cut by an indistinct whitish subbasal line; first line white, bisinuate, direct, edged posteriorly with black; round-orbicular and 8-shaped discal spots outlined with black; a black blotch representing claviform; dorsum suffused with blackish between first and second lines; second line slender, white, rather oblique, slightly curved from $\frac{1}{4}$ to $\frac{3}{4}$, edged anteriorly with some black scales; subterminal line slender, indistinct, white, interrupted, angulated inwards in middle, space between this and second line marked with suffused black streaks on veins; a row of small black spots round apex and termen, separated with white on terminal edge: cilia grey-whitish, with grey subbasal line. Hindwings $1\frac{1}{5}$, without hairs in cell; grey-whitish, greyer towards termen; cilia whitish, with faint greyish subbasal shade.

West Plains, Invercargill, in December (Philpott); one specimen. Perhaps most allied to *acharis*.

TORTRICIDAE.

Catamacta chrysomela n. sp.

♂. 17 mm. Head pale grey. Palpi 2, fulvous-ochreous, towards apex grey. Antennal ciliations 1. Thorax grey, a small spot on shoulders and posterior crest fulvous-orange. Abdomen light grey. Forewings elongate, posteriorly dilated, costa gently arched, with moderate fold from base to $\frac{2}{5}$, apex obtuse-pointed, termen slightly sinuate, rather oblique; deep fulvous-

orange: cilia concolorous, tips grey-whitish. Hindwings grey; cilia pale grey.

Kaeo (near Whangaroa), in January (Hudson); one specimen. Singularly distinct.

Capua plagiatana Walk.

Mr. Philpott has sent me connecting varietal forms of this extraordinarily variable species, which have convinced me that *tornota* Meyr. cannot be maintained as specifically distinct from it.

Epichorista persecta n. sp.

♂♀. 18–19 mm. Head, thorax, and abdomen ochreous-whitish. Palpi 4, pale ochreous sprinkled with fuscous, scales of upper and lower edge white. Antennal ciliations of ♂ 1. Forewings suboblong, costa gently arched, apex obtuse, termen slightly rounded, rather oblique; ochreous-whitish, sprinkled with light-brownish, in ♂ posteriorly tinged with light-brownish between veins; a narrow irregular rather dark fuscous streak mixed with brown through disc from base to apex, marked with a blackish spot at $\frac{2}{5}$; a black dot beneath this near apex: cilia whitish, on termen partially tinged with brownish towards base, and marked with three blackish basal dots on upper part of termen. Hindwings and cilia whitish.

Tisbury and West Plans, in November (Philpott); two specimens.

The following form I had at first regarded as a new species, but now consider it probably only a variety of *persecta*, though so different in appearance as to deserve a varietal name; the structure appears identical.

Var. semicocta.

♀. 19 mm. Forewings whitish-ochreous, on costal half suffused with brownish-ochreous; outer edge of basal patch acutely angulated above middle, angle marked with blackish, with black dots above, before, and below it; central fascia oblique, blackish and rather narrow on upper half, on lower half broader, brownish-ochreous, with several undefined black dots on its edges; costal patch elongate, narrow, ochreous-brown mixed with dark grey; a transverse mark of reddish-ochreous suffusion before termen towards middle, marked in middle with a small black spot, and above and beneath this with two or three minute black dots: cilia ochreous. Hindwings and cilia whitish.

Tisbury, in November (Philpott); one specimen.

Epichorista carcharodes n. sp.

♂. 13 mm. Head and thorax ochreous-brown. Palpi $1\frac{3}{4}$, loosely scaled, ochreous. Antennal ciliations somewhat over 1. Abdomen dark fuscous. Forewings suboblong, costa anteriorly moderately arched, without fold, posteriorly nearly straight, apex obtuse, termen slightly rounded, little oblique; ochreous-brown, towards costa anteriorly suffusedly mixed with whitish-grey-ochreous; markings dark purplish-leaden, edged with scattered whitish-grey-ochreous scales, especially towards costa; a series of dots or short strigulae along costa; two or three irregular marks about edge of basal patch; two irregular oblique transverse streaks indicating margins of central fascia, somewhat angulated in disc, second with irregular projections posteriorly above and below middle; an irregular transverse streak

near before termen: cilia dark purple-leaden, on termen mixed with brownish-ochreous and towards tips ochreous-whitish. Hindwings dark fuscous, becoming blackish posteriorly; cilia dark purplish-grey with blackish subbasal line, towards tips whitish on upper part of termen, and on a patch above apex.

Kaeo, in January (Hudson); one specimen. An obscure species, probably allied to *zatrophana*.

Harmologa antitypa n. sp.

♂. 18 mm. Head fuscous-whitish. Palpi hardly over 2, whitish mixed with fuscous, terminal joint very short, dark fuscous. Antennal ciliations 1. Thorax whitish-fuscous, somewhat mixed with brownish and dark fuscous. Abdomen whitish-ochreous. Forewings suboblong, rather narrowed towards base, costa anteriorly gently arched, with moderate fold from base to $\frac{1}{3}$, posteriorly faintly sinuate, apex obtuse, termen nearly straight, little oblique; fuscous suffusedly irrorated with whitish, and sprinkled with ferruginous and blackish specks; markings rather darker fuscous, with some indistinct strigulae of blackish and ferruginous irroration; outer edge of basal patch indicated by an angulated streak, with a strong prominence at angle; central fascia moderately broad, very irregular, from before middle of costa to beyond middle of dorsum, both margins sharply indented above middle and prominent below it; two small spots on costa beyond this; a suffused streak from costa towards apex to dorsum before tornus, curved inwards in middle and outwards below middle; a small spot on costa just before apex; a subtriangular patch before lower portion of termen, touching tornus: cilia grey-whitish, indistinctly barred with fuscous. Hindwings pale greyish, suffusedly marbled with darker; cilia whitish, with grey subbasal line.

Wellington, in November (Hudson); one specimen. Intermediate between *amplexana* and *scoliastis*.

Harmologa allogama n. sp.

♂ 14–15 mm., ♀ 16–17 mm. Head and thorax dark purple-fuscous. Palpi in ♂ under 2, dark fuscous; in ♀ 2, whitish mixed with fuscous. Antennal ciliations in ♂ $1\frac{1}{2}$. Abdomen dark fuscous. Forewings in ♂ elongate, rather dilated posteriorly, costa gently arched, with moderate fold from base to $\frac{2}{5}$, apex obtuse, termen somewhat sinuate, little oblique, in ♀ more oblong, costa anteriorly moderately arched, then nearly straight; dark fuscous, more or less wholly suffused with deep purple; a patch of ochreous-whitish irroration extending along dorsum from $\frac{1}{4}$ to $\frac{3}{4}$, upper edge indented in middle; in ♂ a patch of deep-ferruginous suffusion sprinkled with yellowish on costa towards apex; in ♀ a semioval yellow-whitish blotch extending along costa from $\frac{2}{5}$ to near apex; termen slenderly suffused with deep ferruginous: cilia dark purplish-leaden, with blackish subbasal line, in ♀ slightly mixed with whitish beneath apex. Hindwings dark fuscous; cilia in ♂ grey with black subbasal line, in ♀ lighter grey, tinged with whitish beneath apex, with dark-fuscous subbasal line becoming deep ferruginous round apex.

Karori, in garden, in December (Hudson); four specimens (2 ♂, 2 ♀). Nearest *achrosta*; the difference in the sexes is very remarkable.

Eucosmidae.

Argyroploce chlorosaris n. sp.

♂. 17 mm. Head and palpi whitish. Thorax grey. Abdomen whitish-yellowish, towards apex pale grey. Forewings suboblong, costa towards base strongly arched, then nearly straight, apex obtuse, termen rounded, rather oblique; white, faintly ochreous-tinged; markings violet-grey, somewhat mixed with dark fuscous; a moderate basal fascia, outer edge rather irregular, straight, direct; dorsal half between this and central fascia irregularly spotted; central fascia rather widely interrupted above middle, upper portion forming a flattened-triangular patch extending along costa from before middle to $\frac{4}{5}$, lower portion moderately broad, dilated beneath and extending from middle of dorsum to tornus, thence continued as a broad violet-grey terminal fascia diminishing to apex, marked with dark fuscous about middle of termen, and ending at apex in a ferruginous-brown spot: cilia pale grey with darker subbasal shade. Hindwings grey, suffused with whitish-yellowish in disc and towards base; cilia whitish-grey, on dorsum suffused with whitish-yellowish. Hindwings beneath with large subdorsal tuft of long whitish-yellowish scales.

Day's Bay, Wellington Harbour, in December, very rare (Hudson); one specimen A remarkable and distinct species.

Copromorphidae.

This small family, whose position is still somewhat doubtful, has not previously been recorded from New Zealand; it consists of a few Indo-Malayan forms, with representatives in Australia and the South Pacific islands. Possibly the singular genus *Isonomeutis* should be referred to this family.

Phycomorpha n. g.

Head with loosely appressed scales; tongue short; ocelli absent. Antennae $\frac{1}{2}$, in ♂ with strong flat dentations, basal joint moderately without pecten. Labial palpi long, curved, oblique y ascending, second joint much thickened with dense scales, roughly expanded on posterior half above and slightly rough beneath, terminal joint $\frac{1}{2}$–$\frac{3}{4}$ of second, cylindrical, hardly pointed. Maxillary palpi obsolete. Thorax with posterior crest. Posterior tibiae with appressed scales or slightly roughened above. Forewings with tufts of scales on surface; 1*b* furcate, 2 from towards angle, 3–5 approximated, 7 to termen, 8 and 9 stalked, 11 from middle. Hindwings over 1, subovate, cilia $\frac{1}{4}$–$\frac{1}{5}$; lower margin of cell with basal pecten of hairs, 3 and 4 connate or short-stalked, 5 somewhat approximated towards base, 6 and 7 parallel.

Type, *metachrysa* Meyr. I refer also to this genus *prasinochroa* Meyr. from New South Wales, hitherto included in *Copromorpha*, from which genus I now distinguish the present by the stalking of the veins 8 and 9 of forewings.

Phycomorpha metachrysa n. sp.

♂. 19–20 mm. Head pale greenish-ochreous, forehead mixed with purplish and spotted with dark fuscous. Palpi purplish-fuscous irrorated with dark fuscous, edges of second joint sprinkled with whitish, terminal joint half second, blackish, base and apex whitish. Thorax pale ochreous

mixed with purplish and spotted with dark fuscous, crest olive-green. Forewings elongate, rather dilated posteriorly, costa slightly arched, apex rounded-obtuse, termen rounded, somewhat oblique; dull purple sprinkled with blackish, tips of scales golden-metallic; costa and dorsum strigulated and spotted with blackish; basal and discal areas irregularly marked with dull greenish and black; in one specimen a large trapezoidal whitish-ochreous blotch extending on dorsum from $\frac{1}{4}$ to tornus and reaching more than half across wing, narrowed upwards; cilia bronzy-grey barred with blackish. Hindwings and cilia grey.

Dunedin, in November and February (Philpott); two specimens.

OECOPHORIDAE.

Saropla Meyr.

This characteristically Australian genus, which has vein 7 of forewings running to termen, and the second joint of palpi more or less tufted loosely towards apex beneath, has not been recorded from New Zealand. The following species probably represent an immigrant type from Tasmania.

Saropla austrina n. sp.

♂. 12–13 mm. Head pale grey, side tufts and collar whitish. Palpi rather dark grey sprinkled with whitish, second joint with short rough projecting scales towards apex beneath. Antennal ciliations $1\frac{1}{2}$. Thorax and abdomen grey. Forewings elongate, costa gently arched, apex tolerably pointed, termen hardly rounded, very oblique; rather dark grey, somewhat mixed irregularly with white; a black line beneath fold from base to $\frac{2}{5}$ of wing, its extremity connected with tornus by a patch of white suffusion surrounded by some scattered black scales; discal stigmata approximated, black, first linear, second forming a transverse spot, connected by a patch of white suffusion, second followed by a clear white patch extending to termen, surrounded by some scattered black scales: cilia pale grey mixed with white. Hindwings grey; cilia grey-whitish.

Ben Lomond, in November (Philpott); two specimens.

Borkhausenia eriphaea n. sp.

♂. 19–20 mm. Head and thorax dark grey, apex of patagia and posterior edge of thorax pale ochreous. Palpi whitish irrorated with grey. Antennal ciliations 1. Abdomen grey. Forewings elongate, rather narrow, somewhat dilated posteriorly, costa gently arched, apex obtuse, termen very obliquely rounded; lilac-brown, sometimes mixed with grey, anterior half of costa suffused with grey, scales of costal edge whitish from $\frac{1}{3}$ onwards; dorsum obscurely paler and ochreous-tinged from base to beyond middle, forming an undefined streak of which the upper edge is marked in middle with a black linear dot followed by a whitish mark: cilia pale ochreous suffusedly irrorated with grey. Hindwings grey; cilia pale grey, on costa ochreous-whitish.

Ben Lomond, in November (Philpott); two specimens. Allied to *perichlora*.

Trachypepla amphileuca n. sp.

♂. 16 mm. Head fuscous. Palpi dark fuscous sprinkled with whitish. Antennal ciliations 1. Thorax white, anterior margin narrowly dark fuscous.

Abdomen light grey, anal tuft whitish-ochreous. Forewings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; white, with a very faint ochreous tinge; a dark-fuscous wedge-shaped spot along basal sixth of costa; a broad direct transverse dark-grey band occupying median third, anterior edge slightly concave, posterior slightly convex and somewhat excavated above middle; within this band are two tufts almost on anterior edge representing first discal and plical stigmata, and a crescentic transverse white dark-edged mark towards posterior edge; a suffused grey patch towards lower part of termen, touching tornus; a small black apical spot, preceded by a large black dot on costa and three on termen: cilia grey, round apex with base white. Hindwings grey; cilia pale grey, darker towards base.

Wainuiomata, in December (Hudson); one specimen. Allied to *euryleucota*, but quite distinct; the wholly white posterior third of costa distinguishes it from that and the allied species.

Trachypepla importuna n. sp.

♂♀. 16–18 mm. Head and thorax whitish-grey. Palpi ochreous whitish tinged with grey except towards apex of joints. Antennal ciliations of ♂ $1\frac{1}{2}$. Abdomen whitish-ochreous. Forewings elongate, rather narrow towards base, costa gently arched, apex obtuse, termen very obliquely rounded; pale fuscous, somewhat mixed with whitish; a triangular fuscous patch extending over basal $\frac{2}{5}$ of costa and reaching to below fold, edged posteriorly by an inwardly oblique series of three suffused subconfluent dark-fuscous spots, two lower tufted; stigmata small, dark fuscous, plical beneath first discal; second discal connected with tornus by a streak of fuscous suffusion, mixed with dark fuscous, preceded on upper part by some raised white scales; spots of fuscous suffusion on costa beyond middle and at $\frac{3}{4}$; from second of these an indistinct angulated fuscous line runs to tornus; a series of cloudy dark-fuscous dots round posterior part of costa and termen: cilia pale fuscous. Hindwings whitish-fuscous; cilia fuscous-whitish.

Ohakune and Wellington, in January (Hudson); four specimens. An obscure species, perhaps nearest *ingenua*.

Trachypepla vinaria n. sp.

♂♀. 19–21 mm. Head whitish-ochreous. Palpi fuscous, apex of joints whitish. Antennal ciliations of ♂ 1. Abdomen whitish-ochreous. Forewings elongate, rather narrow towards base, costa gently arched, apex obtuse, termen rounded, rather strongly oblique; pale-brownish suffusedly mixed with white; a triangular purple-brownish patch sprinkled with dark fuscous extending over basal $\frac{2}{5}$ of costa and reaching to below fold, outer edge inwardly oblique; stigmata dark fuscous surrounded with white, plical slightly beyond first discal; a small undefined brownish-ochreous patch sprinkled with dark fuscous on dorsum beyond middle; an oblique moderately broad brownish fascia from beyond middle of costa to tornus, suffused with purple towards costa, anterior edge traversing second discal stigma and marked with dark-fuscous irroration; a triangular purple-brown spot on costa at $\frac{4}{5}$, whence an indistinct angulated line of dark-fuscous scales runs to tornus; a series of cloudy dots of dark-fuscous irroration round posterior part of costa and termen: cilia whitish, towards tips greyish,

base dotted with dark-fuscous irroration. Hindwings light grey, darker posteriorly; cilia grey-whitish, greyer towards base.

Otira River, in December (Hudson), and I have an example from Greymouth. Allied to the preceding.

Atomotricha Meyr.

I propose to merge the genus *Brachysara* in this, the difference of the palpi being slight; all the species (I now add three more) are very similar, and have more or less slightly developed scale-tufts on forewings; the variation in development of the wings of the ♀ is specific; the palpi are alike in the sexes.

Atomotricha versuta n. sp.

♂. 23–28 mm. Head and thorax pale brownish-ochreous, shoulders or front of thorax sometimes dark fuscous. Palpi whitish-ochreous, with second joint exceeding base of antennae, rather rough towards apex beneath, suffused with dark-fuscous irroration on lower $\frac{2}{3}$ and a subapical ring, terminal joint rather more than half second, more or less sprinkled with dark fuscous. Antennal joints thrice as long as their apical width, ciliations 5. Abdomen whitish-ochreous. Forewings elongate, rather narrow, slightly dilated posteriorly, costa gently arched, slightly sinuate in middle, apex obtuse, termen very obliquely rounded; light brownish-ochreous, with scattered black and dark-fuscous scales, in one specimen suffused with fuscous except on dorsal third; stigmata represented by brownish or fuscous rings, usually incomplete beneath, plical obliquely beyond first discal; sometimes a fine angulated fuscous line from $\frac{3}{4}$ of costa to tornus; in the largest specimen there is a strong black median longitudinal streak from base to $\frac{2}{3}$, thence attenuated to $\frac{5}{6}$: cilia whitish-ochreous mixed with fuscous, with a basal series of blackish dots. Hindwings pale whitish-ochreous more or less tinged or suffused with light grey; cilia pale whitish-ochreous, with several fuscous basal dots.

♀. 17–19 mm. Forewings broad-lanceolate, acuminate; ochreous-brownish or fuscous, dorsal area suffusedly paler or whitish-ochreous; fold more or less suffused with dark fuscous on basal third; stigmata represented by pale-ochreous spots edged about with dark fuscous or blackish. Hindwings rudimentary.

Karori, in August (Hudson); eight specimens (5 ♂, 3 ♀).

Atomotricha ommatias Meyr.

♂ broader-winged than *versuta*, ground-colour always fuscous, stigmata not ochreous. ♀ with forewings not acuminate, hindwings partially developed, ovate-lanceolate. Only from Christchurch, in August and September, other records being erroneous, and founded on confusion with allied species.

Atomotricha isogama Meyr.

Distinguished from all the others by the ♀ being fully winged, as large as ♂. This species and *ommatias* have long palpi.

Atomotricha chloronota n. sp.

♂. 24–25 mm. Head, palpi, and thorax as in *versuta*. Antennal joints four times as long as their apical width, ciliations 5. Forewings elongate, rather narrow, posteriorly dilated, costa gently arched, hardly sinuate in middle, apex obtuse, termen very obliquely rounded; whitish-ochreous, in one specimen purplish-fuscous except dorsal area; a cloudy blackish median longitudinal streak from base almost to apex; in the darker specimen second discal stigma indicated by a pale-ochreous spot touching median streak and pale dorsal area: cilia whitish-ochreous, in the darker specimen mixed with fuscous and dotted with darker at base. Hindwings pale whitish-ochreous partially tinged with grey, especially on a suffused supramedian streak in disc; cilia ochreous-whitish.

♀. 17 mm. Forewings broad-lanceolate, acuminate; purplish-fuscous, with whitish-ochreous dorsal area; second discal stigma represented by a cloudy ochreous-whitish spot ringed with dark fuscous. Hindwings rudimentary.

Invercargill (Philpott); three specimens (2 ♂, 1 ♀).

Atomotricha sordida Butl.

Recognizable by the short palpi and narrow forewings, usually with dark median stripe; ♀ unknown, but probably approaching that of the following species, its nearest ally. Formerly taken plentifully near Christchurch by Fereday, but seems to have disappeared.

Atomotricha oeconoma n. sp.

♂. 23 mm. Head whitish-ochreous. Palpi with second joint fuscous, not reaching base of antennae, scales roughly projecting beneath towards apex, terminal joint sprinkled with fuscous. Antennal joints thrice as long as their apical width, ciliations 5. Thorax fuscous. Abdomen whitish-ochreous. Forewings elongate, narrow towards base, hardly dilated, costa gently arched, apex tolerably pointed, termen nearly straight, very oblique; fuscous, mixed with grey in disc; dorsum suffused with pale ochreous towards base, edged by a blackish raised dot at $\frac{1}{5}$ of wing; stigmata undefined, pale ochreous, plical nearly beneath first discal: cilia fuscous sprinkled with whitish-ochreous, base sprinkled with blackish. Hindwings pale whitish-ochreous, suffused with pale grey except towards apex and posterior part of costa; cilia ochreous-whitish.

♀. 9–10 mm. Forewings ovate-lanceolate; fuscous suffusedly mixed with darker, especially towards base; dorsal area suffused with whitish-ochreous towards base; second discal stigma represented by a raised ochreous tuft edged with dark fuscous. Hindwings rudimentary.

Karori, in August (Hudson); three specimens (1 ♂, 2 ♀). Easily distinguished in both sexes from all except *sordida* by the palpi.

Stenomidae.

Agriophara coricopa Meyr.

Varies considerably in form of wing as well as in development of colouring, some specimens having shorter and broader wings than others, but no two are quite alike, and all differences are connected by transitional forms. A specimen lately received from Mr. Hudson has a broad longitudinal brown stripe from base to apex of forewings.

HELIODINIDAE.

This family has been lately constituted by me. The New Zealand genera referable to it are *Calicotis*, *Vanicela*, *Stathmopoda*, *Pachyrhabda*, and *Thylacosceles*.

Stathmopoda fusilis n. sp.

♂. 15 mm. Head, palpi, and antennae shining ochreous-whitish. Thorax light ochreous-yellow, shoulders ochreous-whitish. Abdomen pale whitish-ochreous. Forewings very narrow, costa gently and evenly arched throughout, apex pointed; shining ochreous-yellow; costa on anterior half suffused with very pale shining leaden-grey, extreme costal edge blackish from base to near middle: cilia pale ochreous-yellowish. Hindwings grey; cilia pale-greyish.

Karori, in December; one specimen. Nearest *phlegyra*, but distinct by the gradual and even curve of costa of forewings, which is unusual in the genus, and absence of defined dark-grey costal streak reaching to $\frac{4}{5}$ of wing.

GLYPHIPTERYGIDAE.

Coridomorpha n. g.

Head smooth; ocelli present; tongue developed. Antennae $\frac{5}{6}$, basal half thickened with dense scales, basal joint elongate, without pecten. Labial palpi long, recurved, second joint thickened with appressed scales, terminal joint $\frac{2}{3}$ of second, slender, acute. Maxillary palpi rudimentary. Posterior tibiae with appressed scales. Forewings with 1*b* furcate, 2 from towards angle, 7 and 8 stalked, 7 to costa, 9 approximated at base, 10 remote, 11 from middle. Hindwings over 1, ovate, cilia $\frac{1}{6}$; 3 and 4 connate, 5 parallel, 6 and 7 slightly approximated towards base.

A very interesting new form, allied to *Heliostibes*, but immediately distinguished by the densely scaled antennae, and costal termination of 7 of forewings.

Coridomorpha stella n. sp.

♀. 18 mm. Head and thorax dark fuscous, with shining light-greenish reflections. Palpi dark bronzy-fuscous, suffused with ochreous-whitish towards base and apex. Antennae fuscous, basal half dark purple-fuscous, above middle with a pale-ochreous band. Abdomen dark fuscous, segmental margins somewhat mixed with purple-bluish. Forewings elongate-triangular, costa anteriorly nearly straight, posteriorly gently arched, apex obtuse, termen rounded, little oblique; dark purplish-fuscous, irregularly irrorated with pale-greenish scales: cilia purplish-fuscous, towards base darker. Hindwings dark fuscous; a dull ochreous-orange streak through disc from near base to $\frac{2}{3}$, extremity enlarged; a fine pale ochreous-orange suffused submedian streak obscurely indicated: cilia whitish-ochreous, with dark-fuscous basal line.

Auckland and Karori, in January and February (Hudson). Mr. Hudson writes as follows: "One at Kauri Gully, Auckland, in January; one at Karori in February: both captured by Stella Hudson this year; never seen before. Wings folded down at back, causing close resemblance to a *Hemipteron* when walking."

Glyphipteryx calliactis n. sp.

♂. 16 mm. Head and thorax dark purple-bronzy-fuscous. Palpi somwehat loosely scaled, white, with four black rings and a black anterior streak towards tip. Abdomen blackish-grey. Forewings elongate, hardly dilated posteriorly, costa slightly arched, apex obtuse, termen obliquely rounded; dark purplish-bronzy-fuscous; five fine oblique violet-metallic streaks from costa between $\frac{1}{3}$ and $\frac{4}{5}$, reaching $\frac{1}{3}$ across wing, fourth longer and directed outwards towards its tip; two short direct white strigulae from costa before apex; a fine rather obliquely curved pale greyish-ochreous streak from $\frac{1}{5}$ of dorsum to fold; a similar shorter ochreous-whitish streak from dorsum beyond middle, its apex nearly connected by a line of violet-metallic scales with a violet-metallic dot on end of cell; a fine somewhat oblique violet-metallic streak from dorsum before tornus, nearly reaching apex of fourth costal; four nearly or partially connected violet-metallic dots in an irregular series before lower part of termen: cilia fuscous with a blackish antemedian line followed on termen by a whitish shade and indented with silvery-white beneath apex, tips at apex forming a blackish hook. Hindwings elongate-oblong, dark purplish-fuscous, lighter on basal half; cilia fuscous.

Kaitoke, bred in September from larvae feeding in flower-stems of *Gahnia* (Hudson); one specimen. Widely distinct from any other New Zealand species.

Glyphipteryx achlyoessa Meyr.

In the ♀ the blackish subbasal line of cilia of forewings is sharply indented beneath apex, in ♂ only sinuate, a curious difference, connected doubtless with the reduction of wing of ♀.

Plutellidae.

Protosynaema steropucha Meyr.

In my original description of this species the examples described were all ♀, not ♂ and ♀ as stated. The antennae of ♂ are really clothed with dense blackish scales to rather above middle, in ♀ clothed with dense scales to $\frac{3}{4}$, this portion being fuscous or dark fuscous except a blackish apical band; naked area of antennae ochreous-whitish. The coppery-metallic markings of forewings vary considerably in development, but the variations are apparently not sexual as stated.

Doxophyrtis n. g.

Head with loosely appressed scales, side tufts somewhat raised; ocelli present; tongue developed. Antennae $\frac{2}{3}$, in ♂ shortly ciliated, basal joint moderate, without pecten. Labial palpi rather long, curved, ascending, thickened with scales and somewhat rough anteriorly throughout, terminal joint longer than second, rather furrowed anteriorly and rough on edges, pointed. Maxillary palpi moderate, porrected, filifrom. Posterior tibiae with appressed scales above, rather rough beneath. Forewings with 1*b* furcate, cell reaching to $\frac{3}{4}$ of wing, 2 from near angle, 7 to apex, 8–10 from near end of cell, 11 from considerably before middle. Hindwings 1, elongate-ovate, cilia $\frac{1}{3}$; 3 and 4 connate, 5–7 approximated towards base.

A remarkable genus, with relationships to the *Glyphipterygidae* and *Hyponomeutidae*, but referable here by the maxillary palpi.

Doxophyrtis hydrocosma n. sp.

♂. 20–22 mm. Head pale ochreous-yellowish, forehead and front of crown more or less suffused with pale bluish-grey. Palpi whitish, anterior furrow of terminal joint blackish. Thorax light ochreous-yellowish, with three dark bluish-grey transverse bars. Abdomen dark grey. Forewings elongate, rather narrow towards base, gradually dilated, costa gently arched, apex obtuse, termen rounded, rather oblique; light ochreous-yellowish, crossed by pale shining bluish-leaden streaks edged with blackish strongly angulated in middle, whitish on costa, their angulations connected in disc by two longitudinal blackish lines; on basal third these anastomose irregularly, then follow three stronger separate streaks more strongly angulated; beyond these are two or three short marks on costa, and an irregular streak before termen, on lower portion indistinct and surrounded with some scattered blackish scales; a black dot on termen above middle; on lower half of termen three or four pale-yellowish dots separated with blackish: cilia pale shining violet-grey, round apex with a blackish basal line Hindwings dark grey, lighter anteriorly; a transverse patch of pale-ochreous hair-scales extending upwards from termen below middle to cell: cilia pale-greyish, with dark-grey subbasal line, at apex suffused with whitish.

Kaeo, at rest on stems of nikau palms, in January (Hudson); three specimens.

LYONETIADAE.

Hieroxestis omoscopa Meyr.

Examples of this species, which I have not seen previously from New Zealand, were forwarded to me by Mr. Hudson from Kaeo and Waikino, under the name of *Opogona apicalis* Swezey. The genus is allied to *Opogona*, but easily distinguished from it by the rough frontal tuft, the head in *Opogona* being entirely smooth. The species is common in Australia and South Africa, which latter country is apparently its home. The larva feeds on cork, &c., and is undoubtedly spread by artificial introduction.

Decadarchis laquearia n. sp.

♂. 11 mm. Head grey, face white. Palpi white, second joint with rough projecting scales towards apex anteriorly. Antennae grey. Thorax and abdomen dark fuscous. Forewings elongate, rather narrow, costa gently arched, apex tolerably pointed, termen sinuate beneath apex, rather oblique; dark purple-fuscous, with light-blue reflections; a slender whitish transverse streak from $\frac{1}{4}$ of dorsum to fold; a thicker oblique whitish bar from $\frac{1}{4}$ of costa to fold beyond it; irregularly curved narrow white transverse fasciae in middle and at $\frac{3}{4}$, connected by a zigzag bar from upper part of first to lower part of second; some scattered white specks between these: cilia grey, basal third on termen prismatic-metallic, round apex whitish cut by two projecting black hooks at apex and two bars above it. Hindwings dark fuscous with bronzy reflections; cilia grey.

Kaeo, in January (Hudson); one specimen. Very distinct.

Erechthias cimmeria n. sp.

♂. 14–15 mm. Head whitish, crown with two dark-fuscous spots. Palpi whitish, second and terminal joints anteriorly tufted with long white

hairs, terminal joint dark fuscous except apex. Antennae greyish, basal joint whitish marked with black. Thorax grey. Abdomen dark fuscous. Forewings elongate, narrow, costa gently arched, apex round-pointed, termen somewhat sinuate, extremely oblique; 7 and 8 stalked; rather dark grey, tips of scales whitish; two ochreous-brown longitudinal lines from base through disc to beyond middle, where they coalesce with very oblique brown streaks from middle of costa and dorsum; an oblique brown mark beneath fold at $\frac{1}{4}$; some scattered black scales on these markings, a black dot on base of dorsum, a small blackish spot on dorsal streak near dorsum, and one on dorsum at $\frac{3}{4}$, whence an obscure brown line runs very near lower half of termen; costal edge dark fuscous, and costal area on posterior half of wing broadly suffused with dark fuscous: cilia fuscous; base, tips, and a faint median line whitish. Hindwings with 5 and 6 stalked; dark fuscous, rather lighter anteriorly: cilia dark grey.

Waitakere, in January (Hudson); two specimens. Allied to *chasmatias*, but wholly different in appearance through the dark colouring.

Tineidae.

Endophthora stereota n. sp.

♂. 7–8 mm. Head, palpi, and thorax ochreous-white. Abdomen grey. Forewings narrow-lanceolate, acute; ochreous-whitish irrorated with pale grey, with some scattered black scales; three black spots on costa margined beneath with brownish-ochreous, first at $\frac{1}{4}$, connected with base by a costal line of black irroration, others before middle and at $\frac{2}{3}$; a small light brownish-ochreous spot beneath middle of disc, connected with dorsum by a group of black scales; a group of black scales on tornus, and a small pale-ochreous spot near termen beyond it: cilia ochreous-grey-whitish, at base with a few black specks. Hindwings grey; cilia ochreous-grey-whitish.

Auckland, in January (Hudson); two specimens. The smallest species of the genus.

Sagephora felix n. sp.

♂. 10 mm. Head and thorax white. Palpi white, second joint dark fuscous except apex. Antennae white, with a blackish band at $\frac{2}{3}$, and tip dark fuscous. (Abdomen broken.) Forewings elongate, rather narrow, costa gently arched, apex tolerably pointed, termen very obliquely rounded; shining snow-white; a dark-fuscous streak along costa from base to $\frac{2}{5}$, edged below with ochreous-brown; a transverse dark-fuscous spot in disc at $\frac{2}{5}$, touching extremity of costal streak; an irregular line of scattered dark-fuscous specks surrounded with some faint pale-yellowish suffusion running from fold before this spot near dorsum, and thence as a subterminal line to a fuscous spot on costa at $\frac{4}{5}$; a rather dark fuscous spot along apical portion of costa: cilia white, on costa barred with fuscous. Hindwings pale whitish-grey; cilia ochreous-whitish.

Kaeo, in January (Hudson); one specimen. Very distinct and interesting.

Bascantis n. g.

Head with loosely appressed hairs on crown, face rough-haired; ocelli present; tongue absent. Antennae nearly 1, basal joint moderate, without pecten. Labial palpi long, curved, porrected, second joint with dense

projecting tuft towards apex beneath, terminal joint as long as second, somewhat thickened with appressed scales, pointed. Maxillary palpi rather long, several-jointed, folded, somewhat loosely scaled. Posterior tibiae smooth-scaled. Forewings with 1*b* furcate, 2 from towards angle, 7 to costa, 11 from before middle. Hindwings 1, trapezoidal, apex obtuse, cilia $\frac{1}{2}$; 2–4 remote, parallel, 5–7 somewhat approximated towards base.

Allied to *Habrophila*, and very similar in colouring, but much broader-winged, and differing in palpi and antennae.

Bascantis sirenica n. sp.

♀. 12 mm. Head and thorax deep purple, face whitish. Palpi dark fuscous. Antennae violet-fuscous. Abdomen dark bluish-grey. Forewings elongate, rather narrow, posteriorly slightly dilated, costa anteriorly slightly, towards apex strongly arched, apex obtuse, termen obliquely rounded; deep purple; a semioval ochreous-white spot on middle of costa, reaching $\frac{1}{3}$ across wing; dorsum obscurely marked with several small blue-metallic spots and minute whitish dots; a transverse-linear blackish mark in disc at $\frac{3}{4}$; a narrow bright-purple transverse fascia shot with metallic-blue and edged anteriorly with indistinct white dots from beyond $\frac{3}{4}$ of costa to tornus, and another before apex: cilia dark grey, with blackish median line. Hindwings dark bronzy-fuscous, lighter anteriorly; cilia dark grey.

Kaeo and Waitakere, in January (Hudson); one specimen.

Tinea mysticopa n. sp.

♂. 17–21 mm. Head fuscous-whitish, forehead more or less suffused with fuscous. Palpi dark fuscous, apex of joints ochreous-whitish. Antennal ciliations $\frac{1}{2}$. Thorax dark fuscous, tips of patagia ochreous-whitish. Abdomen fuscous. Forewings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; bronzy-fuscous, more or less mixed with dark fuscous; an obscure rather broad streak of ochreous-whitish suffusion along dorsum from base to $\frac{3}{4}$, upper edge with short prominences at $\frac{1}{4}$ and middle of wing, edged about them with blackish-fuscous suffusion; second discal stigma represented by a cloudy ochreous-whitish spot; four ochreous-whitish dots on costa posteriorly: cilia fuscous mixed with ochreous-whitish, on basal third darker fuscous barred with whitish. Hindwings light shining brassy-grey, paler posteriorly; cilia whitish-grey.

Invercargill, in October (Philpott), and Greymouth; two specimens.

Tinea conferta n. sp.

♂♀. 13–16 mm. Head fuscous. Palpi dark fuscous, apex of joints whitish-ochreous. Antennal ciliations of ♂ $1\frac{1}{2}$. Thorax dark fuscous more or less mixed with lighter, apex of patagia ochreous-whitish. Abdomen dark fuscous. Forewings elongate, narrow, costa gently arched, apex obtuse-pointed, termen extremely obliquely rounded; brown, much mixed and suffused with dark fuscous; discal stigmata dark fuscous, moderate, sometimes obscure, plical obliquely before first discal, large, black, raised, preceded and followed by ochreous-whitish spots; sometimes whitish-ochreous spots or groups of scales on costa at $\frac{4}{5}$ and on middle of termen: cilia brownish, with two dark-fuscous shades. Hindwings deep fuscous-purple; cilia fuscous, with dark-fuscous medium shade.

Wellington and Otira River, in December and January; nine specimens. I have hitherto erroneously regarded this as *certella* Walk.; I now find that the name *certella* is properly applicable to the species which I described last year as *Trithamnora improba*, which latter specific name must therefore sink.

Tinea margaritis n. sp.

♂♀. 10–11 mm. Head whitish, in ♂ fuscous on crown. Palpi whitish, with a blackish lateral line not reaching apex of joints. Thorax dark fuscous, posteriorly white. Abdomen dark grey. Forewings elongate, narrow, costa gently arched, apex round-pointed, termen extremely obliquely rounded; dark purple-bronzy-fuscous; six shining whitish spots or streaks from costa and three on dorsum, first costal at $\frac{1}{4}$, slender, oblique, second in middle, sometimes broader and less oblique, third at $\frac{2}{3}$, short, wedge-shaped, last three wedge-shaped, approximated, towards apex, first dorsal irregularly elongate, second semioval, in middle, third small, triangular, before tornus: cilia whitish-fuscous, with two dark-fuscous lines on middle of termen with a strong white bar. Hindwings silvery-grey, with bronzy reflections; cilia light grey.

Tisbury, in December (Philpott); Karori, in dense forest (Hudson); two specimens. Allied to *astraea*. Both collectors suggest that the species is a mimic of *Glyphipteryx*, and the resemblance is certainly remarkable, yet there is no reason to suppose that the species of *Glyphipteryx* are distasteful or in any way protected; it is an interesting case for investigation.

Prothinodes n. g.

Head densely rough-haired; ocelli present; tongue absent. Antennae nearly 1, in ♂ pubescent, basal joint moderate, with slight pecten. Labial palpi long, curved, subascending, second joint with short dense projecting tuft towards apex beneath and some long lateral bristles, terminal joint as long as second, compressed and furrowed anteriorly, obtuse. Maxillary palpi long, several-jointed, folded, filiform. Posterior tibiae clothed with very long dense hairs. Forewings with 1*b* furcate, 2 from towards angle, 7 to costa, 8–10 from near end of cell, 11 from much before middle. Hindwings 1, elongate-ovate, cilia $\frac{2}{3}$; 2–4 remote, parallel, 5 and 6 rather approximated towards base, 7 parallel.

Type, *lutata* Meyr.; I also refer *grammocosma* Meyr. here. I formerly regarded this as a *Tinea*, but now see that the palpi are sufficiently different to require generic separation.

Prothinodes lutata n. sp.

♂. 22 mm. Head ochreous-whitish. Palpi ochreous-whitish, terminal joint with a blackish line in anterior furrow. Antennae ochreous-whitish, base lined with blackish. Thorax light-brownish dorsally suffused with whitish, edges of patagia whitish. Abdomen whitish-ochreous suffused with pale grey. Forewings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; ochreous-whitish, with some scattered brownish scales; costal edge blackish on basal third; a slender attenuated dark-fuscous streak beneath costa from base to $\frac{2}{5}$; submedian fold suffused with ochreous; a streak of brown and dark-fuscous irroration along dorsum from base to $\frac{2}{3}$, two large dark-fuscous dots transversely placed in disc

beyond $\frac{2}{3}$, lower slightly anterior; a series of blackish dots round posterior part of costa and termen to $\frac{3}{4}$ of dorsum: cilia ochreous-whitish, at apex with a fuscous dot before tips. Hindwings grey, darker posteriorly; cilia ochreous-whitish, tinged with grey except on costa.

Kaeo, in January (Hudson); one specimen. The very similar *grammocosma* is smaller, and has forewings much more pointed, more brownish-mixed, with distinct brown subdorsal stripe throughout, becoming dark fuscous at apex, and hindwings dark purplish-fuscous with grey cilia.

Mallobathra araneosa n. sp.

♂. 10–11 mm. Head, thorax, and abdomen whitish-grey. Antennal ciliations 2. Forewings elongate, costa gently arched, apex obtuse, termen very obliquely rounded; 6 present; whitish-grey or pale grey, strewn with dark grey sometimes suffused strigulae: cilia grey-whitish or whitish-grey. Hindwings with 6 and 7 stalked; whitish-grey, thinly haired: cilia grey-whitish.

Ben Lomond and The Hump, 2,000–3,000 ft., in November and February (Philpott); three specimens.

Mallobathra lapidosa n. sp.

♂♀. 11–13. Head and thorax dark fuscous, in ♀ mixed with pale ochreous. Palpi dark fuscous, apex pale ochreous. Antennae in ♂ dentate, ciliations 3. Abdomen dark fuscous. Forewings elongate, moderate, somewhat dilated posteriorly, costa gently arched, apex obtuse, termen obliquely rounded; 6 present; dark purplish-fuscous, in ♂ strewn throughout with cloudy whitish-ochreous dots, larger and distinct on costa, especially posteriorly, on dorsum with small distinct whitish-ochreous spots before and beyond middle, in ♀ mottled irregularly with well-marked pale-ochreous spots and strigulae; an indistinct cloudy dark-fuscous spot on end of cell: cilia purple-fuscous, with golden reflections. Hindwings with 6 absent; in ♂ dark bronzy-fuscous, in ♀ dark grey: cilia bronzy-grey.

Wellington, Karori, bred in January (Hudson), details not given; four specimens (2 ♂, 2 ♀). Has been confused with *crataea*, but differs by dentate antennae of ♂, and vein 6 of hindwings absent in both sexes

Mallobathra globulosa n. sp.

♂. 13–14 mm. Head and thorax light greyish-ochreous, shoulders suffused with dark fuscous. Palpi short, fuscous, loosely rough-scaled. Antennal ciliations 5. Abdomen pale-greyish. Forewings elongate, slightly dilated posteriorly, costa gently arched, faintly sinuate in middle, apex obtuse, termen very obliquely rounded; 6 present; ochreous-whitish irrorated with pale grey, more or less suffusedly mixed with fuscous and dark-fuscous scales and strigulae; markings dark fuscous; a basal patch extending on costa to $\frac{1}{4}$, narrower on dorsum but undefined; a spot on middle of dorsum; a moderate fascia from middle of costa to dorsum before tornus; a blotch on costa at $\frac{3}{4}$; five round nearly confluent spots along termen from apex to tornus: cilia ochreous-whitish, more or less mixed suffusedly with fuscous. Hindwings with 6 present; grey, paler and thinly scaled anteriorly: cilia whitish-grey.

West Plains, Invercargill, in September (Hudson); two specimens.

MICROPTERYGIDAE.

Sabatinca rosicoma n. sp.

♂♀. 7 mm. Head whitish-ochreous suffused with purplish-rosy. Papli ochreous-whitish. Antennae ochreous-whitish, in ♂ greyish-suffused, in ♀ with dark-fuscous bands above and below middle. Thorax deep purple, anterior margin golden. Abdomen dark fuscous. Forewings ovate-lanceolate; deep purple, with coppery-bronze reflections; base narrowly whitish; a subtriangular whitish blotch on dorsum in middle of wing, its apex subtruncate, reaching half across wing; in ♂ whitish dots on costa before middle and at $\frac{3}{4}$: cilia grey, at apex with a whitish spot. Hindwings dark purple-fuscous; cilia dark fuscous.

Kaeo, in January (Hudson); four specimens (1 ♂, 3 ♀).

ART. XVIII.—*Descriptions of New Species of* Lepidoptera.

By ALFRED PHILPOTT.

Communicated by Dr. W. B. Benham, F.R.S.

[*Read before the Otago Institute, 7th October, 1913.*]

HYDRIOMENIDAE.

Tatosoma fasciata sp. nov.

♂♀. 31 mm. Head and thorax dull greyish-green. Palpi elongate, in ♂ 2, in ♀ 3, brownish-green mixed with grey. Antennae ochreous. Abdomen grey. Forewings, *costa strongly arched at base*, termen sinuate above middle, oblique, *in ♂ greyish-green, in ♀ white;* a thin irregular black line near base, its extremity produced shortly along dorsum, posteriorly margined with ochreous, especially near dorsum; an obscure whitish basal line; median band broad, blackish-brown, its anterior margin from $\frac{2}{5}$ costa to $\frac{1}{2}$ dorsum, irregular, in ♀ widely indented at middle and oblique at dorsum, posterior margin from before $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum, moderately angled above middle; an elongate black discal dot; three or four indistinct waved dark-green lines between basal line and median band, in ♀ more distinct and suffused with ochreous; in ♀ median band margined on both sides with ochreous and broadly centred with ground-colour; subterminal line indistinct, waved, white, preceded by two or more obscure dark-greenish lines, in ♀ these are ochreous and the termen also broadly ochreous; a series of paired black dots along termen: cilia grey with darker line. *Hindwings shining white*, in ♀ with faint broad median and terminal shades; lobe in ♂ $\frac{1}{4}$: cilia shining white.

Not very closely related to any other species of *Tatosoma;* compared with the other small-lobed forms, it is distinguished from *tipulata* by the posterior edge of the median band not being bent obliquely outwards near dorsum, and from *topea* by the white hindwings and elongate palpi.

Lake McKenzie, in November. ♂ and ♀ types, the only specimens at present known, taken by Messrs. M. O. Pasco and J. Speden.

Venusia dissimilis sp. nov.

♂♀. 35 mm. Head ochreous-brown. Palpi black. Antennae fuscous, whitish in ♀. Thorax and abdomen brown mixed with ochreous and grey.

Forewings triangular, costa faintly sinuate in middle, apex subacute, termen bowed, oblique; *ochreous-brown;* veins dotted alternately with black and white; a number of blackish faintly-waved lines from costa to dorsum, inwardly very oblique; four or five from apex to near middle of dorsum more pronounced and forming an obscure median band; a thin black waved terminal line; a black discal dot: cilia ochreous-brown with two darker lines. *Hindwings, costa elongate, termen almost straight, waved;* whitish-grey; numerous faint waved brown lines parallel to termen, a more distinct darker one beyond middle followed by lighter ground-colour: cilia as in forewings.

♀ as ♂, but ground-colour grey-brown.

Nearest to *V. verriculata*, but very distinct; the unusual form of the hindwing is comparable only with *Epirranthis hemipteraria*.

Ben Lomond, in February; two of each sex taken by Mr. M. O. Pasco.

SELIDOSEMIDAE.

Selidosema lutea sp. nov.

♂. 47 mm. Head, palpi, and thorax dull yellowish-brown, face paler. Antennae moderately bipectinated, yellowish-brown. Abdomen pale yellow-brown. Forewings strongly arched at base, costa faintly sinuate, apex subacute, termen sinuate, rounded beneath, oblique; *dull yellowish-brown* with a few scattered blackish scales, most plentiful near apex; basal line indicated by a few blackish scales at dorsum; *first line much interrupted, dentate, black, most pronounced as an inwardly oblique mark on dorsum;* a series of obscure interneural black dots on termen: cilia dull yellowish-brown with obscure darker line. Hindwings, termen sinuate; very pale yellowish-brown; a prominent black discal dot and some black scales round termen: cilia pale yellowish-brown with faint darker line and tips whitish.

Nearest to *S. lupinata*, but that species differs in the yellower hindwings without discal lunule, and is also a considerably smaller form.

Bold Peak, Humboldt Range. A single ♂ taken by Mr. C. Fenwick in December, 1913. Several others were secured by Mr. W. G. Howes in February, 1914.

CRAMBIDAE.

Orocrambus scoparioides sp. nov.

♂. 17 mm. Head, palpi, and thorax reddish-brown, palpi mixed with yellowish. Antennae fuscous. Abdomen brown, somewhat yellow laterally. Forewings, costa straight, apex subacute, termen straight, rounded beneath, slightly oblique; bright reddish-brown, rather infuscated towards base; a linear yellowish mark along dorsum at base; *first line white, obscure, inwardly indented at middle, broadly margined with fuscous posteriorly;* some white suffusion following this, more pronounced on dorsal half; *second line white; distinct, outwardly indented above middle;* veins irregularly marked with black: cilia ochreous-brown with darker basal line. Hindwings dark fuscous: cilia ochreous, paler on apical half. Undersides brownish-yellow.

A remarkable form, remote from any species of the genus yet discovered, and superficially closely resembling a *Scoparia*.

Ben Lomond, December. Two taken by Mr. C. Fenwick at about 3,800 ft., and another obtained at Paradise in April. Mr. W. G. Howes also took a specimen at Commissioner's Creek in February. Probably generally distributed throughout the Wakatipu district.

Tortricidae.

Tortrix tigris sp. nov.

♂. 22 mm. Head and palpi ochreous. Antennae ochreous, annulated with black, ciliations 1. Thorax pale ochreous mixed with brown. Abdomen pale ochreous-grey. Forewings elongate-ovate, costa strongly arched, fold $\frac{2}{5}$, apex subacute, termen markedly sinuate, slightly oblique ; whitish-ochreous mixed with brown ; markings fuscous-brown, distinct ; *posterior edge of basal patch very oblique, deeply and widely indented at middle ; median fascia very broad, anterior edge from $\frac{1}{3}$ costa to beyond $\frac{1}{2}$ dorsum, almost straight posterior edge from $\frac{2}{3}$ costa to tornus, sinuate ;* an irregularly wedge-shaped fascia midway between median fascia and apex, its anterior edge strongly sinuate : cilia fuscous-brown. Hindwings whitish-grey, faintly ochreous-tinged round termen : cilia whitish-grey, fuscous towards apex.

Nearest to *T. torogramma*, but easily distinguished by the form of the basal patch and the median fascia.

Tisbury, Invercargill. One example, beaten from *Dicksonia fibrosa*, in January.

Harmologa palliata sp. nov.

♂. 24–27 mm. Antennae black annulated with whitish. Head, palpi, and thorax dark fuscous mixed with yellowish-grey. Abdomen dark fuscous, segmental divisions grey. Forewings suboblong, costa rather straight, fold slight, termen slightly oblique, rounded beneath ; *dark fuscous, densely strewn with pale-yellow scales which tend to become tinged with blue near costa and dorsum :* cilia fuscous-grey, darker near apex. Hindwings dark reddish-fuscous, sometimes strongly suffused with red in disc : cilia grey, with one or more obscure darker lines. Undersides : Forewings bright yellow with suffused fuscous blotch on apical third ; hindwings bright yellow with scattered fuscous scales.

♀. 29 mm. Head, palpi, thorax, and abdomen grey-whitish tinged with yellow. Forewings oblong, termen faintly sinuate ; *pale fuscous, thickly strewn with light-yellow scales, towards middle of costa scales tend to become bluish-white :* cilia grey mixed with fuscous, Hindwings fuscous-grey tinged with pale yellow : cilia white with two obscure darker lines. Undersides : Forewings yellowish-grey ; hindwings pale clear yellow.

Distinguished from all the other large species of *Harmologa*, except *aenea*, by the absence of markings on the forewings. The latter species I have not seen, but *palliata* seems to differ in the colour of both fore and hind wings.

Obelisk, Old Man Range, Central Otago. Taken commonly by Messrs. A. Hamilton and W. G. Howes early in February, 1912. I am indebted to Mr. Howes for three fine males. In December of the same year I found both sexes fairly plentiful on the Takitimu Mountains at about 3,500 ft.

Oecophoridae.

Cremnogenes nigra sp. nov.

♂. 15–17 mm. Head, palpi, antennae, thorax, and abdomen black, antennal ciliations $4\frac{1}{2}$, in whorls at joints. Forewings moderate, termen oblique ; *blackish-fuscous ; a broad white irregular stripe along dorsum from base to near tornus, mixed with yellow at base, bent upwards and enclosing a spot of ground-colour on posterior half,* sometimes more or less obsolete : cilia dark fuscous. Hindwings and cilia dark fuscous.

Differs from *C. oxyina* in the larger size, absence of lateral thoracic spots, and more uniform colour.

Ben Lomond, in November. Common on *Nothofagus Solandri*, at 2,000 ft. to 3,000 ft.

HEPIALIDAE.

Porina fusca sp. nov.

♂. 32–35 mm. Head and thorax dark brownish-ochreous. Antennae shortly bipectinate. Abdomen grey. Forewings, costa straight, apex obtuse, termen obliquely rounded; dark fuscous-brown; veins outlined with darker; a triangular white dot below costa at $\frac{1}{3}$, margined beneath with black; an irregular more or less triangular white spot beyond this, margined with black; *an irregularly sinuate white mark from base at middle to before* $\frac{1}{2}$, *suffusedly margined with black;* a white dot on dorsum at $\frac{1}{2}$, margined beneath by a Λ-shaped black mark; an indistinct chain of white-margined fuscous spots from costa near apex to tornus, ending on tornus in a Λ-shaped black mark; a subterminal series of obscure white-centred fuscous marks; a series of interneural triangular fuscous dots on termen: cilia ochreous, indistinctly barred with fuscous. Hindwings fuscous: cilia as in forewings.

♀. 35 mm. Forewings light fuscous, markings almost obsolete; indications of a dark streak from base below costa, another below this, and a white spot in disc at about $\frac{1}{2}$: cilia fuscous mixed with ochreous. Hindwings pale fuscous-grey: cilia as in forewings.

Nearest to *P. despecta*, but smaller, and with a different arrangement of spots. The lower basal streak seems to be the most distinctive marking.

Bold Peak, Humboldt Range; and Ben Lomond, Wakatipu. The first specimen brought under my notice was taken by Mr. C. Fenwick, who found it common on Bold Peak, at 4,500 ft., in December. Mr. M. O. Pasco also met with it commonly on Ben Lomond in the same month. Probably the species is distributed throughout the Wakatipu region.

Porina aurimaculata sp. nov.

♂. 70 mm. Head and thorax dark brown. Antennae reddish, strongly bipectinate. Abdomen ochreous-fuscous. Forewings elongate, termen strongly oblique; bright brown tinged with ochreous and suffused with darker on basal half of costa; an irregular dark-fuscous blotch on dorsum at base; a similar blotch beyond this, irregularly margined with white; *a large broadly oval, dark-fuscous spot below middle at* $\frac{1}{4}$, *touching similar spot obliquely beyond,* irregularly white-margined; several white, or dark fuscous margined with white, spots in disc; some bent linear whitish marks on costa at $\frac{1}{2}$; a double series of irregular dark-fuscous spots parallel with termen, more or less white-margined, *and those towards middle golden-centred;* a terminal series of small white-margined fuscous spots: cilia ochreous, barred with dark fuscous, tips somewhat whitish. Hindwings ochreous-brown: cilia as in forewings.

This magnificent species differs from all the other members of the genus, except *P. dinodes*, in the strongly bipectinated antennae of the ♂. From *P. dinodes* it can be separated by the narrower wings and the golden-centred spots. The pectinations of the antennae are also slightly shorter in *P. aurimaculata*.

The Hermitage, Mount Cook. A single specimen taken at light on the 28th March by Mr. F. S. Oliver.

Art. XIX.—*New* Lepidoptera (Geometridae).

By Louis B. Prout, F.E.S.

Communicated by W. George Howes, F.E.S., F.L.S.

[*Read before the Otago Institute, 4th November, 1913.*]

Xanthorhoe declarata n. sp.

♂. 36–38 mm. Very closely related to *X. clarata* Walk., but apparently quite distinct. Differs in the greyer brown (not ochreous) markings of the forewing and the white (not yellow or ochreous) hindwing. Forewing with the second subbasal white fascia less strongly curved; discal dot enlarged, touching the first post-discal fuscous line; outer boundary of median area less deeply inbent on fold; white subterminal line less deeply dentate. The first fuscous post-discal line, though too variable in both species to give a constant distinction, is, as a rule, sharply outangled between veins 6 and 7 in *clarata*, but in *declarata* only very obtusely bent or very gently curved. The hindwing beneath differs still more markedly: in *clarata* its basal half, though partly dark-marked, is encroached upon by a deep and large pale prong running inwards at vein 5 as far as the discocellulars (in some, measure even to the base) and another on the fold; in *declarata* the basal half is much more uniformly dark-marked, its distal edge only forming two very moderate inward bends. Abdomen also whitish, dorsally with pairs of rather dark spots.

From *cataphracta* Meyr., which is also related, *declarata* differs especially in the angulation of the distal edge of the median band.

Ben Lomond, 12th February, 1912; 4 ♂ (including the type). Queenstown, 26th January, 1912; 1 ♂, kindly presented by Mr. W. G. Howes. Other examples are in his collection.

Tatosoma apicipallida n. sp.

♂♀. 33 mm. Face and palpus blackish dusted with bright red, the palpus also mixed with whitish scales and with the tip white. Thorax and base of abdomen similarly coloured, abdomen otherwise grey, edged with black at the incisions. Forewing whitish-grey with pink reflections, basal one-third and an apical patch mostly whiter; a small basal patch of black and bright-red scales produced along posterior margin to $\frac{1}{3}$; the lines formed of accumulations of blackish scales sprinkled with bright-red ones; three or four faint waved lines between basal patch and median area, followed nearly at middle of wing by stronger double line (proximal edge of median area) bending outward in cell, then inwards as far as submedian fold, then again outwards, crossed by dark marks at costal, median, and submedian veins; cell-spot present; distal part of median area occupied by three dark strongly dentate lines which run nearly parallel with the preceding but diverge somewhat in costal region and enclose some dark shading; these lines also somewhat dark-marked on submedian vein; pale area at apex enclosing a small dark subapical patch on costa; a terminal series of double dark dots, thick and somewhat elongate: cilia apparently dark grey with lighter line at base (defective).

Hindwing uniform glossy pale grey with a slight ochreous tinge: cilia concolorous. Under-surface very weakly marked, forewing showing some slight pale markings on costa and traces of the distal boundary of median area, the terminal area being very slightly lighter in parts.

The type ♀ was taken on the slopes of Ben Lomond, Lake Wakatipu, on the 18th November, 1910, and very kindly presented by the captor, Mr. W. G. Howes. The co-type is a ♂ sent me subsequently, labelled "Humboldts, 24th December, 1911," and which Mr. Howes tells me was taken with others on Bold Peak by Mr. C. Fenwick, through whose generosity it now stands in my collection.

The wings are not quite so extremely narrow, the ♂ abdomen not quite so extremely elongate, as in the most typical members of the genus.

Chloroclystis (Pasiphila) rufulitincta n. sp.

♂. 27 mm. Structure rather similar to that of *bilineolata*, the type of the section *Pasiphila;* both the palpus and the antennal ciliation slightly shorter, face less tufted, discocellulars of hindwing appreciably though not strongly biangulate. Face and palpus light grey. Head and thorax grey mixed with reddish. Abdomen dark grey with a dorsal belt at base and a media-dorsal line whitish-grey, the anterior segments also marked dorsally with red. Forewing rather elongate, with termen strongly oblique; glossy pinkish-grey; a small basal patch and a very broad median band dull-reddish, the proximal edge of the latter from nearly $\frac{1}{3}$ costa to $\frac{2}{5}$ posterior margin, angled basewards between submedian fold and vein 1, outwards at vein 1; its distal edge from costa at fully $\frac{2}{3}$, oblique outwards to behind vein 4, where it is scarcely 2 mm. distant from termen, here forming a sharp tooth or prong and a second scarcely less sharp behind vein 3, then retracted basewards, finally rather direct from vein 2 to tornus, but indented on submedian fold; the brightest and most compact part of this median band is its proximal half (narrowing somewhat costally), the distal half being more or less dissolved into wavy lines and its outer boundary in the posterior part of the wing not sharply defined, as it here almost meets some terminal shading; a narrow brown band from costa near apex ending in a point half-way across wing; some dark shading along termen: cilia grey, darker barred. Hindwing rather elongate, with termen not crenulate; glossy grey with indistinct beginnings of darker lines on abdominal margin. Under-surface of forewing greyish, with dark discal mark and beginnings of dark lines on costa; of hindwing paler than above, with dark discal spot and several indistinct angled dark lines, especially in basal half.

A single specimen, taken on the slopes of Ben Lomond, on the 18th November, 1910, by Mr. W. G. Howes; kindly presented by the captor. Recognizable by its large size (equal to the largest *bilineolata*), shape, coloration, &c.

Art. XX.—*A Species of* Daphnia *new to New Zealand.*

By Gilbert Archey, B.A.

[*Read before the Philosophical Institute of Canterbury, 4th June, 1913.*]

Hitherto only three species of *Daphnidae* have been recorded from New Zealand. In 1878 Mr. G. M. Thomson* described a form which he named *Daphnia obtusata*, and which he said occurred "in great abundance in still water in neighbourhood of Dunedin from October to May." This has since been obtained in other parts of New Zealand, and is now placed under *Simocephalus*, to which genus Sars,† who had raised it from dried mud afterwards sent to him, pointed out it belonged. Thomson‡ again, in 1883, described a new species of *Daphnia* under the name of *D. similis*. This form was obtained from a pool in Eyreton, North Canterbury. In 1894 dried mud from the same pool was forwarded to Sars, who obtained from it several kinds of *Entomostraca*, among which was the form *D. similis* of Thomson. Sars (*loc. cit.*) pointed out that the specific name *similis* had already been given by Professor Claus to another species of *Daphnia;* he therefore renamed the New Zealand species, after its discoverer, *D. thomsoni*. In his account he mentions the interesting fact that he had also raised the same species from mud collected at Knysna, Cape of Good Hope. He also describes a species of *Ceriodaphina* (*C. sublaevis*) from the same mud that yielded *Simocephalus obtusata* and *Daphnia thomsoni*.

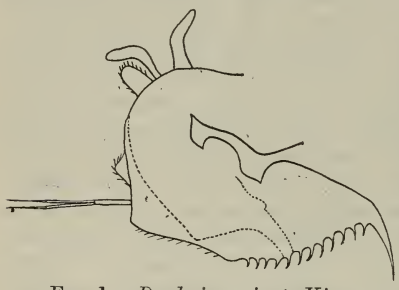


Fig. 1.—*Daphnia carinata* King: abdominal region; from the right side.

At the end of November, 1899, the late Mr. G. R. Marriner obtained a number of specimens of a *Daphnia* from a pool of water in a shingle-pit at Middleton, near Christchurch. These have not hitherto been fully examined, but comparing them with similar specimens collected recently by Mr. C. Barham Morris, of Oamaru, they appear to belong to *D. carinata* King,§ a form originally described in 1853 from specimens obtained from ponds and swamps around Sydney. Several varieties of the species were recorded by King. The forms collected in New Zealand appear closely to resemble the variety *cephalata*, of which King gives a sketch, but which he does not describe in the text.

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* Thomson, G. M.: "On the New Zealand *Entomostraca*." Trans. N.Z. Inst., vol. 11, 261, pl. xi, fig. E, 2 *a–e*.

† Sars, G. O.: "Contributions to the Knowledge of the Fresh-water *Entomostraca* of New Zealand, as shown by Artificial Hatching from Dried Mud." Videnskabselskabets, Skrifter i, Mathem-naturv. Klasse, 1894, No. 5.

‡ Thomson, G. M.: "On a New Species of *Daphnia*." Trans. N.Z. Inst., vol. 16, p. 240, pl. 13, figs. 6–9.

§ King, Rev. R. L.: "On some Species of *Daphnidae* found in New South Wales." Proc. Roy. Soc. Tasmania, vol. 2, part 2, January, 1853, pp. 242–53, pl. 1. And "On Some Australian *Entomostraca*—in Continuation," pp. 253–55, pl. vi, A, B.

Jules Richard* included *D. carinata* King in his "Revision des Cladocères," and remarked that Sars had "observed this species, of which he is about to publish a description." Sars, in his paper of 1894, referred to in the beginning of this paper, noted a certain similarity in appearance between *D. thomsoni* and *D. carinata*. He says, "The species (*D. thomsoni*) is very nearly allied to *D. carinata* King, of which I have had specimens for examination, differing somewhat, however, in the form of the rostrum and in the structure of the tail. The carina of the head is, moreover, far from being so strongly developed as in that species, and the spine of the carapace is also less elongated, sometimes even very short."

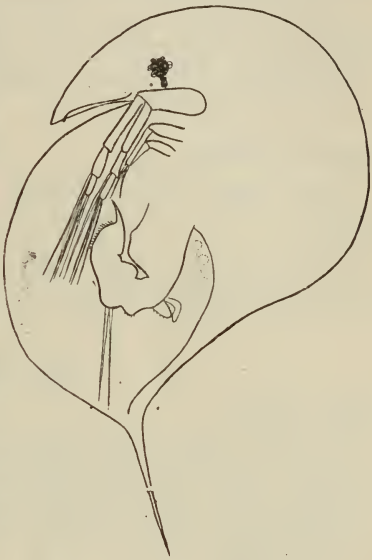

FIG. 2.—*Daphnia carinata* King; viewed from left side.

The specimens of *D. carinata* found at Middleton and at Oamaru, in New Zealand, are characterized by the expansion of the anterior half of the carapace into a large circular carina which surmounts the head and anterior portion of the body, ending under the head in a distinct rostrum. On the posterior surface of the rostrum, a short distance above its point, is a small angular depression to the level of which the very small antennules project. The posterior spine of the carapace is slightly less than one-half of the length of the carapace proper. The dorsal portion of the abdomen is provided with four median dorsal processes, the anterior two of which are somewhat longer and narrower than the posterior two, which are more rounded and setose.

This species has, up to the present, been recorded only from Middleton, near Christchurch, and from Oamaru.

ART. XXI.—Diptera *of the Kermadec Islands.*

By DAVID MILLER.

[*Read before the Otago Institute, 7th October, 1913.*]

SOME time ago a collection of *Diptera* from the Kermadec Islands was sent to me for identification by Dr. Hilgendorf, of Lincoln College. These flies were collected on Sunday Island by Mr. W. L. Wallace, a member of Mr. R. B. Oliver's expedition to the Kermadecs during 1908. A number are common to the Kermadec Islands, Australia, and New Zealand, but there are no types of the last country among the collection.

Unfortunately, the greater part of this collection is seriously damaged, so that the following brief list is all that can be drawn up.

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* Richard, J.: "Revision des Cladocères." Ann. des Sci. Nat., Zool., 8 sér., tom. 2, 1896, pp. 223–28, pl. 23, figs. 10, 11, 16.

Fam. Syrphidae.

Syrphus novae-zealandiae.

Three males and two females. One specimen captured on toetoe, Denham Bay, 20th August; four specimens captured while hovering over *Solanum* and Tongan bean on No. 3 Terrace, north coast, 24th August.

Common in still, bright weather. Abundant throughout New Zealand and found in Polynesia.

Syrphus viridiceps.

Three males and one female. Captured hovering over *Solanum*, in sunshine, on No. 3 Terrace, 16th September. A male and female taken in coitu.

This species is found both in Australia and New Zealand, and is identical with Captain Hutton's *S. obesus*.

Fam. Anthomyidae.

Ophyra nigra.

Two males and four females. Common. Two specimens caught in sunshine on ngaio-tree, Denham Bay, 20th August; four from the carcase of a goat, north coast, 9th November.

Common about dead sheep in Western Australia, but not, so far, found in New Zealand.

Fam. Dexiidae.

Dexia rubricarinata.

Five males and four females. Captured from the carcase of a goat, north coast, 9th November.

An extremely abundant and very troublesome fly. This species has a wide distribution from China, through the East Indies, Australia, Tasmania, and the Kermadecs, to New Zealand. I procured a large number at Astrolabe during the summer of 1911.

Fam. Muscidae.

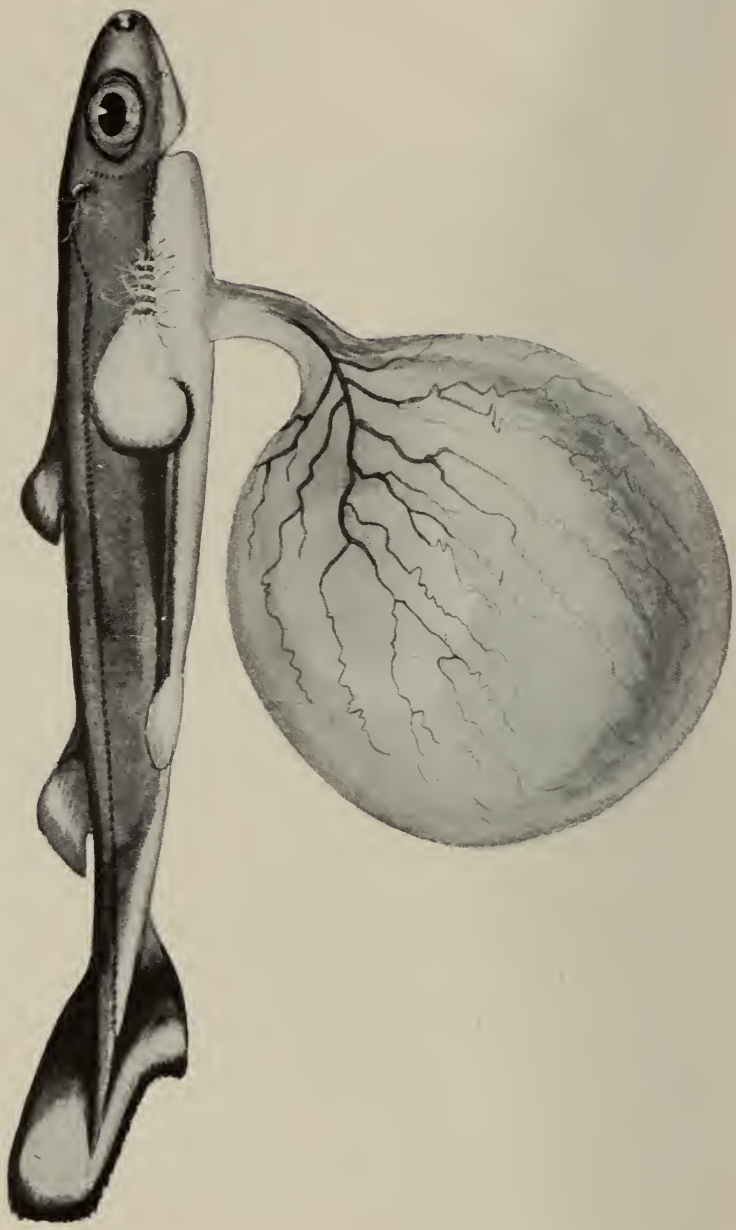
Calliphora laemica.

Five males and six females. Abundant in sunny places all over the island. The specimens were captured while flying in a warm cave, known as the Oven Cave, on the shores of the Green Lake, in the crater, 30th October.

Common in Australia, Polynesia, and New Zealand.

There are also a number of the *Muscidae acalyptratae* which I am unable to identify at present.

The *Nemocera* are represented by two species of *Culicidae*, a Tipulid, and some species of the *Mycetophilidae*, all of which are so much damaged that identification, beyond the families, is impossible.



Centrophorus plunketi *Waite*

Edgar R. Waite del.]

[*Face p. 127.*

ART. XXII.—*Notes on New Zealand Fishes: No. 4.*

By EDGAR R. WAITE, F.L.S., Curator, Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 3rd December, 1913.*]

Plates III–VI.

SEVERAL interesting fishes are herein dealt with. Two of them (*Mora pacifica* and *Melanostigma flaccidum*) are described as new, and provide the first occurrence of their respective genera in New Zealand seas. A second occurrence of *Scymnorhinus licha* is noted. Foetal specimens of *Centrophorus plunketi* are described and figured, and similar treatment is accorded an example of the deal or unicorn fish, identified with *Lophotes cepedianus*.

16. Centrophorus plunketi Waite.

Plate III.

Centrophorus plunketi Waite, Trans. N.Z. Inst., vol. 42, 1910, p. 384, pl. xxxvii.

This species was first diagnosed four years ago from an example caught off Kaikoura, and in July last (1913) I received a second specimen from the same locality, by favour of Messrs. Nilsen Brothers.

This individual is slightly smaller than the previous one, being 1398 mm. in length. It also is a female, and is interesting from the fact that it was gravid, thirty-six young ones being obtained from the uteri. They are all of similar size, being 165 mm. in length, but had evidently not nearly reached their full foetal development, as the yolk-sac is large (66 mm. in diameter) and almost globular. At this stage the gills are still external, being apparent as red filaments, and, as usual, branchial filaments are also protruded through the spiracle. The predorsal spines do not at this stage show the protective knobs found in the foetus of *Squalus*,* though they may be a later foetal development.

In its ball-like form and short thick peduncle, the yolk-sac of *Centrophorus* agrees with *Squalus*, and differs greatly from that of *Galeus*, which I have described† as of peculiar shape, provided with a long umbilical cord, entering the sac towards the larger end.

The colour of the adult shark is uniform dark brown; it is interesting, therefore, to find that the foetal examples are white beneath, as with the majority of adult fishes and sharks, perhaps indicating that the uniform coloration of *Centrophorus* and *Scymnorhinus* is an acquired character.

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* Waite, Rec. Aust. Mus., vol. 4, 1901, p. 33, pl. iv, fig. 2.
† Waite, *ibid.*, 1902, p. 175, fig. 19.

17. Scymnorhinus licha Bonnaterre.

Plate IV, fig. 1.

Squalus licha Bonnaterre, Tabl. Encycl. Ichth., 1788, p. 12.

Mr. A. Hamilton, Director of the Dominion Museum, Wellington, forwarded to me for determination, a shark which proves to be of this species. It was originally recorded as an inhabitant of New Zealand waters by the late T. J. Parker,* who identified an example taken near Otago Heads, in 1882, with *Scymnus lichia.*

Though the specimen now to hand does not constitute a record for the Dominion, it is of sufficient interest to note as being only the second specimen known from our seas. Parker's example was a gravid female; ours is a male, and measures 1250 mm. in total length. Both agree in being of uniform dark-brown coloration.

A cast of the specimen was made for exhibition in the Canterbury Museum, and a photograph of the cast is reproduced on Plate IV, fig. 1. It should be noted that while the relative position of the fins, &c., is fairly well shown, the head appears much too short owing to the distortion produced by the angle subtended by the photographic lens.

An excellent figure, of which I have seen a tracing, will shortly be issued by Mr. A. R. McCulloch. The specimen selected for illustration is one of nine examples taken by the Federal trawler "Endeavour" in the Australian Bight.

18. Mora pacifica sp. nov.

Plate V.

D. 7, 44; A. 17, 18; P. 18; V. 6; C. 21 + 14; L. lat. 94; L. tr. 9 + 23.

Length of head, 4·0; height of body, 3·1; length of caudal, 5·5 in the length: diameter of eye, 3·2; length of snout, 5·2; and interorbital space, 4·8 in the head

Head flat; snout depressed; mouth oblique, the maxilla extending to beneath the third fourth of the orbit, upper jaw a little the longer; eye large, near to the upper profile; interorbital space broad and flat; a barbel below the chin.

Teeth.—Cardiform teeth in bands in the jaws and on the vomer; none on the palatines.

Fins.—The first dorsal commences three-fourths of an eye-diameter behind the head, or one-fourth its distance from the snout to the middle caudal rays; its anterior rays are twice as long as the eye; the fin is joined by membrane to the second fin, which extends posteriorly beyond the termination of the second anal. The anterior anal commences nearer the end of the middle caudal rays than the snout, and it is widely separated from the second anal. The pectoral is placed rather low, close behind the head, and its length equals its distance from the anterior margin of the orbit; its root is wholly in advance of the dorsal, and it reaches to below the third ray of the second fin. The ventral base lies wholly in advance of the pectoral; its first ray is produced as a bristle, its total length being equal to the post-orbital length of the head. The caudal is slightly forked, and its narrow low peduncle is but five-sixths the diameter of the eye in depth.

Scales.—The head and body entirely covered with moderate cycloid scales. The lateral line is complete; it arises behind the opercle, and, form-

* Parker, Trans. N.Z. Inst., vol. 15, 1883, p. 222.

Fig. 1.—Scymnorhinus licha *Bonnaterre.*

Edgar R. Waite, photo.]

Fig. 2.—Lophotes cepedianus *Giorna.*

Edgar R. Waite, photo.]

Face p. 128.]

Mora pacifica *Waite.*

Edgar R. Waite, photo.]

ng a low curve over the pectoral, passes along the middle of the caudal peduncle to the base of the rays.

Colours.—The upper surface is grey, the sides pinkish, and the underparts white; the fins are reddish, with exception of the pectoral, which is grey.

Length.—700 mm.

Loc.—Kaikoura, 200 fathoms.

The type of the genus *Mora** is known only from the Mediterranean and eastern Atlantic, and is common at great depths.

Judging from the figure published by Goode and Bean,† the new species differs from *M. moro* in having a shorter snout, the first dorsal fin less advanced (considerably behind the root of the pectoral instead of above it), and the latter fin longer, extending beyond the first ray of the second dorsal. The nostrils are not shown in the figure quoted. These authors state that there are teeth on the palatines. Günther‡ writes, "Teeth on the vomer and sometimes on the palatines." There is no trace of palatine teeth in our specimen: they are probably lost in adult life.

19. **Melanostigma flaccidum** sp. nov.

Plate VI.

Length of head and depth of body, 6·6 in the total; diameter of eye, 4·0 in the head.

The maxillary extends to below the middle of the eye. The length of the head is four-fifths its distance from the anal. Pectoral one-third the length of the head.

Length.—204 mm.

Colour.—Milky-white as seen through the gelatinous scaleless skin; dorsal surface finely spotted with black; end of tail black, the colour continued forwards along the edges of the fins as shown in the figure; lining of mouth, gill-opening, and vent black.

Loc.—Surface of the sea, Kaikoura.

This specimen appears to differ from the type of the genus, *M. gelatinosum* Günther,§ in the much deeper body and slightly shorter head and pectoral fin, while the markings, as described, do not correspond. It must not, however, be overlooked that a fish a noticeable character of which is an extremely loose skin, may assume different proportions according to its condition or method of preservation, and I shall not be surprised if the Kaikoura specimen proves to be but another example of *M. gelatinosum.*

The type specimen was taken in Magellan Strait at a depth of 24 fathoms, but the vertical range of the species is very remarkable, individuals having been secured from a depth of 641 fathoms, while the Kaikoura example was taken alive at the surface of the sea.

I have to thank Mr. Carl Jensen for the specimen, which was captured on the 25th April, 1913.

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* *Gadus moro* Risso, Ichth. Nice, 1810, p. 116. *Mora mediterranea* Risso, Hist. Nat. Europ. Merid., iii, 1826, p. 224. *Asellus canariensis* Valenciennes, Nat. Hist. Iles Canariennes, Poiss., p. 76. *Pharopteryx benoit* Ruppell, Verzeichn. Mus. Senckenb., Fische, 1852, p. 16. NOTE.—The name *Asellus*, as used by Valenciennes, does not appear in the various *Nomenclatores zoologici.*

† Goode and Bean, Oceanic Ichth., 1895, p. 369, fig. 322.

‡ Günther, Cat. Fish. Brit. Mus., vol. 4, 1862, p. 341.

§ Günther, Proc. Zool. Soc., 1881, p. 21, pl. ii, fig. *a.*

20. Lophotes cepedianus Giorna.

Plate IV, fig. 2.

Lophotes cepedianus Giorna, Mem. Accad. Torino, xvi, 1809, p. 19, pl. ii, fig. 1.

Mr. A. Hamilton, Director of the Dominion Museum, sent a specimen of *Lophotes*, upon which he asked me to report.

Parker* appears to have been the first to record *Lophotes* from New Zealand, and, knowing only of *L. cepedianus*, assumed that his specimen was of the same species. The Dunedin record was followed by a notice by Clarke,† who reported the stranding of a specimen on the Waiwakaiho Beach, Taranaki. Clarke did not see the fish, but identified it generically from verbal descriptions and drawings, one of which he reproduced.

We next find that Hutton,‡ though giving the references to the papers of Parker and Clarke, enters the New Zealand species as *L. fiski* Günther.§ He seems to have had no specimen for examination, and *L. fiski* is such a peculiar form that he was clearly wrong in identifying with it the specimens described by Parker and Clarke. Upon the authority of the "Index" *L. fiski* was entered in my "Basic List"|| but the species should evidently be erased from the New Zealand fauna. When describing this fish in 1890 from a specimen stranded at the Cape, Günther mentioned that three nominal species had been then described—namely, *L. cepedianus* Giorna, *L. capellei* Schlegel, and *L. cristatus* Johnson—but remarked that all three were possibly of the same species. He had then overlooked the fact that Johnston¶ had associated his own name with a *Lophotes* taken in Tasmanian waters: *L. guntheri* is described as having reticulate markings. More recently, Kershaw** identified with *L. cristatus* a specimen taken in Victorian waters, but I have not seen his note. As my private library is packed for transport, I am unable to make further notes on the history of the fishes of this genus.

The subject of this note was obtained in the Wellington district, and a cast was made for exhibition in the Canterbury Museum. A photograph of this cast is reproduced herewith, and shows the general proportions of the fish, its peculiar flat shape rendering it tolerably free from the distortions to which a round fish is subject under the photographic lens The first rays of the dorsal fin and the upper rays of the caudal were broken, otherwise the fish was quite perfect.

The following is a description of the specimen :—

B. vii ; D. 246 ; A. 12 ; P. 13 ; V. 5. L. lat. 25 + 216 ; L. tr. 24 + ?

Length of head, 7·1 ; depth of body, 5·1 in the length : diameter of eye, 3·0 ; and length of snout, 4·5 in the head.

The mouth is small and oblique, and the maxilla extends to below the first fourth of the eye ; the premaxilla forms its entire front border. The eye is circular, and placed nearer the lower than the upper profile. The nostril is a horizontal slit, placed quite anteriorly, close above the mouth.

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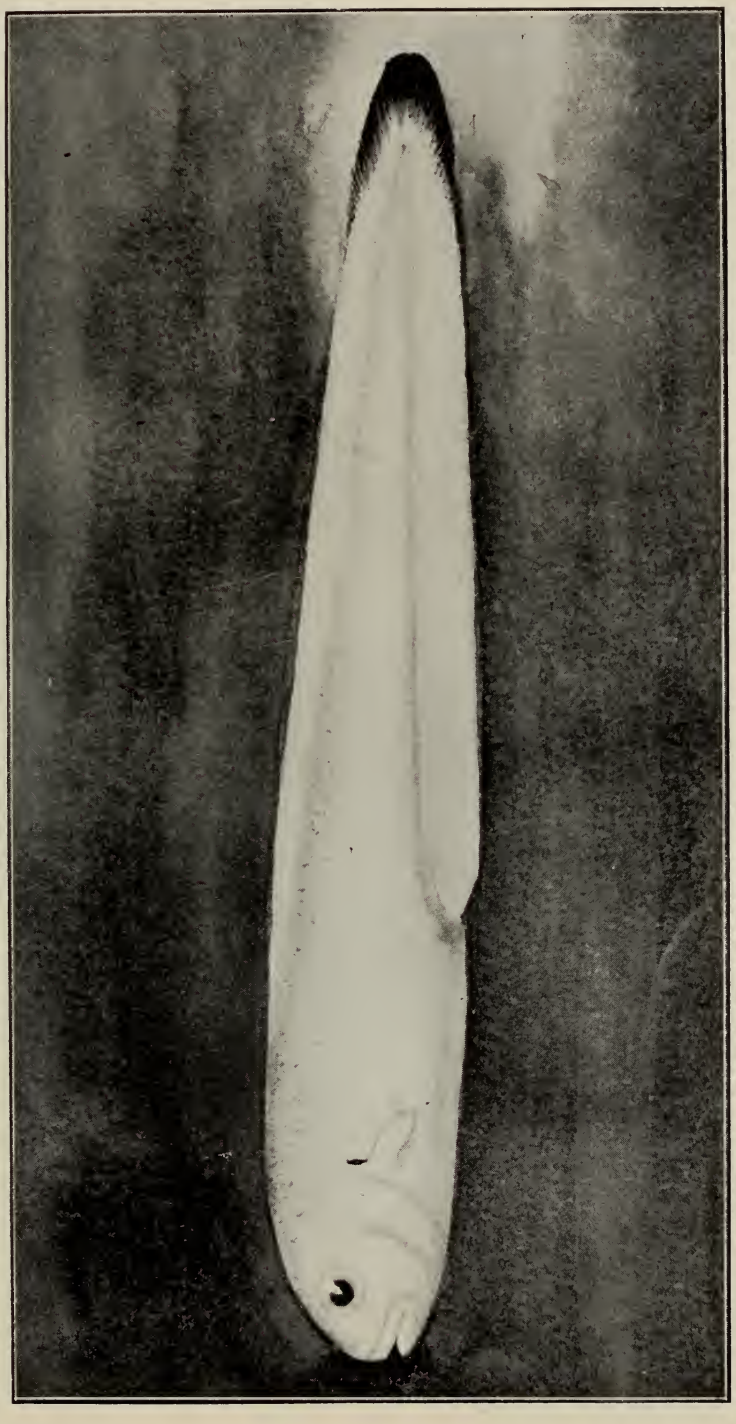
* Parker, Trans. N.Z. Inst., vol. 26, 1894, p. 223.
† Clarke, Trans. N.Z. Inst., vol. 29, 1897, p. 251, pl. xvi.
‡ Hutton, "Index Faunae Novae Zealandiae," 1904, p. 47.
§ Günther, Proc. Zool. Soc., 1890, p. 244, pl. xix, xx.
|| Waite, Rec. Cant. Mus., i, 1907, p. 33.
¶ Johnston, Proc. Roy. Soc. Tas., 1884, p. 142.
** Kershaw, "Victorian Naturalist," vol. 26, p. 78.



Melanostigma flaccidum *Waite.*

Edgar R Waite del.]

Face p. 136.]

The gills are four in number, with a slit behind the fourth; the gill-rakers are moderately long and flat; there are twelve on the first arch, of which eight are on the lower limb. Pseudobranchiae are present. The general contour of the fish is shown by the figure.

Teeth.—The teeth are conical, somewhat separated, forming an irregular band in the upper jaw and a single series in the lower jaw; the vomer and palatines are toothless.

Fins.—The dorsal fin commences as a vertical continuation of the anterior profile of the head, and the first rays form a crest, which, however, is broken; the following rays are of even length, being equal to the diameter of the eye; the posterior rays are a little shorter, and are subcontinuous with those of the caudal. The pectoral has a broad horizontal base, the rays being, therefore, directed vertically; the first or longest ray is one-third longer than the eye, while the ventral is quite small, placed a little behind and below the pectoral. The anal lies near to the extremity of the body, but is not attached to the lower caudal rays.

Scales.—The scales are quadrangular in shape and are extremely thin, and directed in lines obliquely upwards and backwards; their number below the lateral line cannot be counted. The lateral line commences immediately below the first ray of the dorsal fin, and passes in a straight line to a point behind the eye, whence it traverses the middle of the body in a direct line to the caudal.

Colours.—The whole body is of silvery hue, with brighter markings about the size of a florin, the fins pink.

Length.—1140 mm.

I see no reason to dissociate this specimen from the Mediterranean species *L. cepedianus*, nor does the short notice by Johnston indicate that *L. guntheri* is distinct, the reticulate markings described being possibly referable to the scale-pits, which are arranged netwise. Goode and Bean* are inclined to recognize as distinct the Japanese species *L. capellei* Temminck and Schlegel,† and, tentatively, *L. cristatus* Johnson, from Maderia.

EXPLANATION OF PLATES.

PLATE III.

Centrophorus plunketi Waite. Foetus; natural size.

PLATE IV.

Fig. 1. *Scymnorhinus licha* Bonnaterre. Male; about one-seventh natural size. From a cast.

Fig. 2. *Lophotes cepedianus* Giorna. About one-sixth natural size. From a cast.

PLATE V.

Mora pacifica Waite. About one-fourth natural size. From a cast.

PLATE VI.

Melanostigma flaccidum Waite. Slightly reduced.

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* Goode and Bean, Oceanic Ichth., 1895, p. 349 *et seq.*, figs. 389, 390.

† Temm. & Schleg., Fauna Japon., 1845, p. 132, pl. lxxi.

Art. XXIII.—*Description of a Collection of Actinians from the Kermadec Islands.*

By F. G. A. Stuckey, M.A., Wellington.

[*Read before the Wellington Philosophical Society, 27th August, 1913.*]

The specimens were collected by Mr. W. R. B. Oliver in 1908. They include three New Zealand forms previously described, and four species which are new to science. The three forms already known are *Actinia tenebrosa* Farquhar, *Phlyctenactis retifera* Stuckey, and *Paractis ferax* Stuckey.

The distribution of *Actinia tenebrosa* as given by me (1908) limited the species to Stewart Island and the neighbourhood of Cook Strait. Since then Professor Kirk has informed me that he saw it on Auckland Island; so that the distribution of the species may be set down as from the Kermadecs to Auckland Island.

Mr. Oliver's discovery of *Phlyctenactis* extends the distribution of the genus as from Kermadec Islands to Stewart Island.

In my original description of *Paractis ferax*, by a clerical error, I gave the number of mesenteries as 32 to 36 pairs. The species has 24 pairs, of which 6 pairs are perfect and fertile. Two pairs are directives. The mesenteries of the second and third cycles are feebly developed. The perfect mesenteries are as described and figured by me (Trans. N.Z. Inst., vol. 41, p. 388). The chief points in the diagnosis of the species are the muscular body-wall, the ectodermal invaginations and pits in the wall, and the regular hexamerous development of the mesenteries. Mr. Oliver's specimen is larger than any found by me, being 9 cm. in height. This species was found by Mr. Walton in Manukau Harbour, so that its known distribution is Kermadecs to Cook Strait.

The following are the names of the species that are new to science: *Zoanthus atroviridis* n. sp., *Isaurus fuscus* n. sp., *Epizoanthus oliveri* n. sp., and *Metridium canum* n. sp.

Zoanthus atroviridis n. sp.

The collector describes this species as follows: "Dark green. A very slimy form occurring in large dense patches up to half a metre in diameter in rock-pools between tide-marks, Meyer Island. The individuals when expanded touched one another, thus entirely covering the rock-surface, and the colonies were mostly on the northern side of the rock-pools, where they would receive a minimum of sunshine."

Form.—There is a fairly thick encrusting coenenchyme, on which the polyps are arranged in groups rather than in lines or rows. The coenenchyme, as well as the body-wall, is covered with sandy particles. The polyps are of varying size, but all stand well up from the surface of the coenenchyme.

Dimensions (of largest specimen, contracted).—Height, 30 mm.; diameter, 6 mm.; capitulum, 10 mm. in diameter.

Body-wall.—In structure and in histological character the body-wall closely resembles that of *Z. jukesii* (Haddon and Shackleton, Trans. R. Dublin Soc., Dec., 1891). A remarkable character is the great thickness of the mesogloea.

Sphincter Muscle.—There is a well-developed mesogloeal sphincter, very long, and tapering downwards.

Tentacles.—These are short, and in two series, about 40 in each series.

Mesenteries.—In the only specimen that I sectioned the mesenteries presented the usual brachycnemic arrangement. There were a pair of perfect and a pair of imperfect directives. In the sulco-lateral portion I found 14 pairs of mesenteries, and in the sulculo-lateral portion 2 pairs. The mesenterial filaments are of the form typical of the family.

Gonads.—None were found in the specimen sectioned.

Isaurus fuscus n. sp.

Of this species the collector says: "Pale brown. Noticed only in rock-pools between tide-marks, Fishing Rock, Sunday Island."

There is only one specimen in the collection, and its colour in the preserved state is creamy-white.

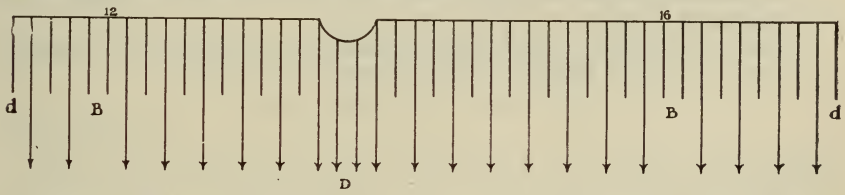
Form.—The base of the column is adherent, and follows the irregularities of the rock to which it is attached. The body is cylindrical, and transversely furrowed in contraction. The specimen had become flattened and misshapen. The oral disc and tentacles were strongly infolded.

Dimensions.—Height, 22 mm.; long diameter of column, 10 mm.; short diameter of column, 5 mm.

Body-wall.—The body-wall is thick, and under the thin cuticle there is a subcuticular or peripheral layer of mesogloea, which is connected with the general mesogloea by strands which cross the ectoderm. The mesogloea is thick, and contains many lacunae and cell-islets. The endoderm is well developed. There are large endodermal and ectodermal bays.

Tentacles.—These could not be seen in the contracted state.

Mesenteries.—These present the usual brachycnemic condition, and were 44 in number. The brachycnemic couples were the twelfth and thirteenth from the perfect directives on one side, and the sixteenth and seventeen on the other side. The arrangement of the mesenteries with respect to the siphonoglyph is shown in the following diagram:—



Sphincter Muscle.—There is a very strong mesogloeal sphincter. The cavities are closely lined with cells, and the mesogloea in the region of the sphincter has a fibrous appearance quite different from that of the other part of the body-wall.

Epizoanthus oliveri n. sp.

The collector's note on this species is: "Plentiful among a close-growing coralline alga in rock-pools between tide-marks, Fishing Rock, Sunday Island."

I have placed this species provisionally in the genus *Epizoanthus*, all recognizable features pointing to the correctness of this classification. The body-wall is so strongly encrusted with sand and other hard bodies that it is impossible to make anything but fragmentary sections.

Form.—There is an encrusting coenenchyme, on which the polyps are closely set. Both coenenchyme and body-wall are encrusted with sand, &c.

Dimensions (of largest specimen, contracted).—Height, 17 mm.; diameter of column, 4 mm.; diameter of disc, 6 mm.

Body-wall.—The wall is thin, the mesogloea occupying the greater part, and sending strands across the ectoderm. The ectoderm is almost obliterated by the great mass of sandy encrustation. The usual cell-islets and lacunae are present in the mesogloea, but I found no sign of an encircling sinus.

Mesenteries.—The imperfect mesenteries are very short. I was unable from my sections to ascertain the exact number of mesenteries, owing to reasons already stated.

Tentacles.—The tentacles were all infolded, and their number and arrangement could not be ascertained.

Sphincter Muscle.—Traces of a mesogloeal sphincter were found.

Metridium canum n. sp.

The collector's description is: "Greyish. Abundant on the under-side of stones near low-water mark, Coral Bay, Sunday Island. This species . . . tolerates a muddy or sandy bottom."

Pedal Disc.—Adherent, rather wider than the column.

Column.—Cylindrical. Longitudinally wrinkled in contraction. Cinclides are present on the upper part of the column.

Tentacles.—About 200 in number, crowded and arranged in four, or perhaps five, cycles. In some of the preserved specimens the tentacles have black tips.

Body-wall.—The usual hexactinian features are observable. The mesogloea is comparatively thick, though variable in different portions of transverse sections. It appears fibrillar in structure, and contains numerous collections of cells.

Sphincter.—A weak mesogloeal sphincter is present.

Mesenteries.—There are four cycles, 45 pairs in all. Of these, only the primaries, 6 pairs in number, are perfect.

Dimensions (of largest specimen, contracted).—Height, 9 mm.; diameter of column, 10 mm.; diameter of disc, 15 mm.

Art. XXIV.—*Notes on a Collection of Cephalopods from the Kermadec Islands.*

By S. S. Berry, Redlands, California.*

[Communicated by W. R. B. Oliver.

[*Read before the Auckland Institute, 3rd December, 1913.*]

[Plates VII–X.

Through the kindness of Messrs. Tom Iredale and W. R. B. Oliver, there has been sent me a small series of Cephalopods from the Kermadec Islands, the attempt to identify which has led to the preparation of this report, the material proving to be unusually interesting. The specimens were collected on Sunday Island by Messrs. Iredale, Oliver, and R. S. Bell in 1908 and

* To avoid delay it has been necessary to print this paper without having the proofs corrected by the author.—Ed.

1910, but only one species, a littoral *Polypus*, was taken alive. The remaining species were only captured by reason of their being wave-bound on the various beaches, more particularly that of Denham Bay; but nearly all the specimens are nevertheless in a very fair state of preservation. In many instances I found the pallial chamber to be partially filled with small pebbles and coarse gravel. Except for this trifling circumstance, there is usually little to indicate that the animals were not taken alive, and most of the damage they have suffered appears to be chiefly traceable to the use of formalin as a preserving medium.

The twenty-four specimens examined represent nine species. These are referable to eight genera, only *Polypus* being represented by more than one type. Four species and one genus appear to be new to the literature. The species which is the type of the new genus has proven to be of so remarkable a character that under the name *Nematolampas regalis* a brief account of it has already been published elsewhere (Berry, 1913). Another of the new forms is an *Abralia* which enables us to throw a little new light upon the value and interpretation of several of the characters commonly depended on as important indices in the classification of the group. One of the new *Polypi* is also of more than ordinary interest. So that in spite of its small size this collection is all in all one of the most noteworthy which it has been my good fortune to have for study.

So far as I can ascertain, no one has recorded any Cephalopods from the Kermadecs in any of the literature, although the "Challenger" Expedition (Hoyle, 1886) obtained *Moschites verrucosa*, *Cirroteuthis meangensis*, and the curious *Amphitretus pelagicus* from very deep water in their immediate vicinity.

The notes here offered give reasons for considering the relationships of the fauna to lie rather with that of the New Zealand archipelago than with those of either the Tonga or Fiji groups, but the evidence is not so conclusive but that future investigations may indicate quite differently.

Fam. ARGONAUTIDAE Cantraine, 1840.

Genus ARGONAUTA Linné, 1758.

Argonauta sp.

There are two specimens of an *Argonauata* in the collection (S.S.B. 403), but I am quite uncertain regarding their identification, since, though both are females, neither is accompanied by its characteristic "shell," upon which single feature most of the specific distinctions relied upon in this group have been based. The entire genus is in need of a careful revision upon the basis of a close comparative study of the animals of both sexes. One of the present specimens proved to contain the well-preserved hectocotylus of a male within the pallial chamber above the left gill. This organ is so peculiar in some of its characters, and has been described in so few species, that a brief account of it will be added below.

Unfortunately, *A. böttgeri* is the only other species with which I have been able to compare the present form. The latter (*i.e.*, the Kermadec form) is a considerably larger species; the body is shorter, and is more full and ovate, lacking any conspicuous humps or torsions.

The hectocotylus is an elongate, slightly curved, firm, and fleshy organ of a length of about 35 mm.; width, 4–5 mm.; distal 5 mm. sharply recurved and connected with the proximad portion of the arm by a very

delicate transparent web. This recurved portion terminates distally in a long filament, which in the present specimen appears coiled up within an elongate semi-transparent sac, which occupies almost the entire outward portion of the hectocotylus. This sac has an opening towards its distal end, through which the filament passes to its connection with the arm proper; beyond this point the skin of the sac is continuous with the above-mentioned web. The delicate skin which forms the outer wall of the sac contains numerous dark chromatophores. The inner face of the arm is considerably wider than the remaining portion, much flattened, and bears 2 ultra-marginal series of crowded suckers, about 36 in each row; these are largest from about the 10th to the 15th pairs, thence diminishing regularly in size nearly or quite to the tip of the arm proper, where they are very small. The suckers have a short columnar form with slit-like apertures; all are closely connected by a membrane.

The more important measurements of both specimens are appended below. The smaller was the one containing the hectocotylus.

Measurements.	Type. mm.	Cotype. mm.
Total length	120	135
Length of body, dorsal	38	40
Tip of body to base of dorsal arms	42	44
Width of body	26	27
Width of neck (nuchal commissure)	18	17
Width across eyes	24	23
Length of funnel	29	26
Length of right dorsal arm (excluding velum) ..	56	70
Length of left dorsal arm (excluding velum) ..	69	60
Length of right second arm	84	87
Length of left second arm	80+	88
Length of right third arm	80	78
Length of left third arm	78	78
Length or right ventral arm	70	77
Length of left ventral arm	68	66
Length of umbrella between dorsal arms ..	18	15
Length of umbrella between ventral arms ..	12	11

These specimens were collected on Denham Bay beach, Sunday Island, by R. S. Bell.

Fam. POLYPODIDAE Hoyle, 1904.

Genus Polypus Schneider, 1784.

Polypus oliveri n. sp.

Body of firm consistency, plump, of rounded pyriform outline, broadest posteriorly, a well-marked longitudinal groove in the median line below. Pallial aperture of moderate width, extending almost exactly half-way between the funnel and eye on either side.

Head short, considerably narrower than the body, from which it is rather poorly delimited by a slight constriction. Eyes elevated, conspicuous, with small puckered openings. Funnel short, bluntly conical, its apex extending about half-way to the margin of the umbrella between the ventral arms.

Arms quite short, on an average somewhat more than four times as long as the body, or three times as long as the head and body taken

together; in length subequal, but the lateral pairs slightly exceeding the dorsal and ventral; stout, conical, little attenuate, rapidly tapering; the first 4 suckers on each arm in a single row, the remainder crowded and in 2 series which are well separated from one another; the suckers attain their maximum in size and crowding at a point just below where the margin of the umbrella joins the arm. Umbrella thick, short, of slightly greater extent dorsally than ventrally, and laterally than dorsally, where it extends for less than a quarter the length of the arms; it is continued as a fleshy fold along the outer surfaces of all the arms.

Surface nearly smooth below, but ornamented above by numerous low, rough, conical tubercles, the skin between which may be either (1) smooth, or (2) finely papillose with smaller tubercles which are similar to the more persistent larger ones except in size. The finer wrinklings and papillations extend over the entire outer and lateral surfaces of the arms, and on the inner surface of the umbrella as well. There are no conspicuous supra-ocular cirri, but the eye-opening appears to be surrounded by a circlet of 5 or 6 low and indistinct papillae.

Colour a dark slate, shading somewhat lighter below. The inner surfaces of the suckers are a conspicuous light brown, sometimes shading to cream.

Two females of this species are in the collection, probably neither of them full grown. The smaller is rather the better preserved, and has been selected as the type (S.S.B. 405). Both were taken alive among the rocks by W. R. B. Oliver in 1908.

Measurements.	Type. mm.	Cotype. mm.
Total length	175	190
Length of body, dorsal	30	27
Tip of body to base of dorsal arms	45	40
Width of body	31	37
Width of neck	23	26
Width across eyes	23	24
Length of funnel	16	17
Length of right dorsal arm	120	133
Length of left dorsal arm	105	130
Length of right second arm	130	144
Length of left second arm	125	144
Length of right third arm	132	142
Length of left third arm	127	140
Length of right ventral arm	120	135
Length of left ventral arm	124	135
Length of umbrella between dorsal arms ..	25	32
Length of umbrella between ventral arms ..	19	27

P. oliveri is one of the rough-skinned *Polypi*, perhaps allied to *P. vitiensis* Hoyle (1886, p. 84), which I have not seen, but the description of which certainly differs in a good many particulars. The present species does not seem to offer any very striking characters of its own, but a careful search through all the available literature has failed to reveal any other named form with which its union seems to me justifiable. To *P. kermadecensis*, the other member of the genus from the Kermadecs, it is in no degree related.

The species is named for Mr. W. R. B. Oliver.

Polypus sp. (young).

A young *Polypus* in the collection (S.S.B. 406) has an elongate cylindrical pointed body, a large head with very large prominent eyes, a short umbrella much better developed ventrally than dorsally, and fairly short subequal arms, the dorsal pair being a little the shortest. The colour is brown, coarsely mottled above with dark grey. The chromatophores are numerous and minute, except a number of larger ones scattered with some regularity over the lower surface of the mantle and a double series of distant chromatophores along the outer aspect of each of the four ventral arms. There are no cirri, but the dorsum is covered with numerous low indistinct papillations which soon become obsolete ventrally.

Though impossible of certain statement, it seems not unlikely that this specimen represents a young stage of *P. oliveri.*

Polypus (Pinnoctopus ?) kermadecensis n. sp. Plates VII and VIII.

Body narrow and elongate for a *Polypus*, the width contained about twice in the length; compressed dorso-ventrally; entire lateral periphery bordered by a thin but conspicuous fold of skin which commences close to or at the mantle-margin just above the funnel, thence gradually widens posteriorly till it reaches a maximum width of nearly a centimetre (half the width of the body) just before rounding the posterior extremity of the body. Except for an abrupt notch-like indentation in the middle behind, the margin of this membrane is entire all round. Mantle-opening ample.

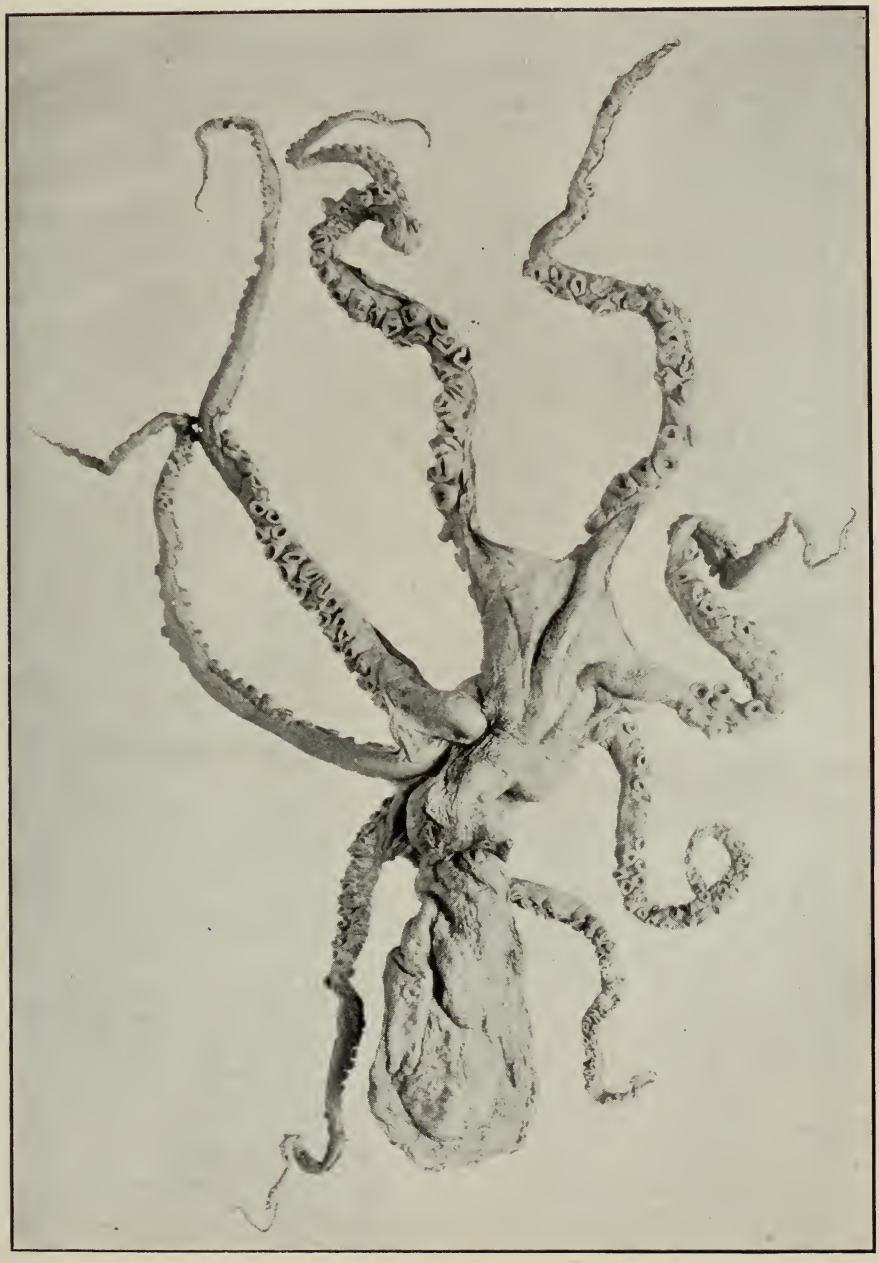
Head small, long and narrow, being mainly composed of the large prominent protruding eyes; a decided constriction separates it from the body. The eyes are very posterior in position, the anterior portion of the head having the appearance of a stout stalk connecting them with the region of the arms. Funnel long and thin-walled, the anterior portion free for a little more than a third of its length; apex not quite reaching past the eyes. Funnel organ in the present material not sufficiently well preserved for description.

Arms exceedingly long, slender, and attenuate; very unequal, their order of relative length 1, 2, 3 = 4. The dorsal arms, which are not only much longer but in every way more robust than those of the remaining pairs, are fully four times as long as the body. Suckers for the most part small, largest just proximad from the middle of each arm, a region where they attain a conspicuous maximum in the case of the dorsal pair; elevated, and everywhere in 2 rather compressed but little crowded rows, save the 4 at the extreme base of each arm which appear in single file. The 8 basalmost suckers (one on each arm) form a circlet about the mouth; they are very minute. Umbrella thin, transparent; best developed dorsally, where it extends between the arms of the dorsal pair for about a sixth of their length; ventrally it is scarcely more than half as long.

Hectocotylus unknown.

Surface everywhere nearly smooth. A few soft tubercles are to be made out just back of and above the eyes, while other scarcely distinguishable papillae are scattered here and there over the dorsum.

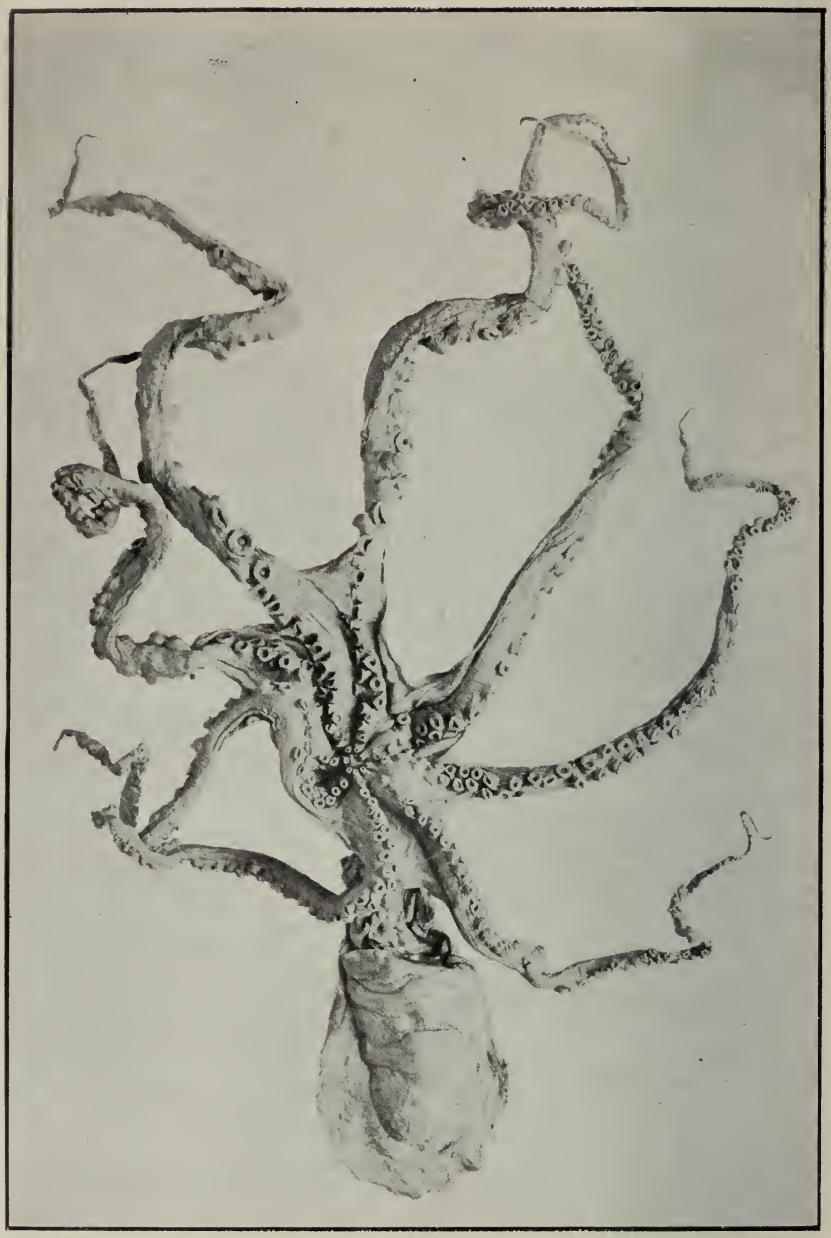
Colour a dull grey-brown, more or less mottled and streaked with slate. No oculations or other definite colour-pattern of any sort is to be made out from the preserved material.



Polypus kermadecensis, ♀.

Dorsal View.

Face p. 138.]



Polypus kermadecensis, ♀.

Ventral View.

Measurements.	mm.
Total length	250
Dorsal length of mantle, excluding web	43
Dorsal length of mantle, including web	50
Width of mantle, excluding web	20
Maximum width of web	9
Width of neck	10
Width of head	17
Length of funnel	18
Length of right dorsal arm	172
Length of left dorsal arm	181
Length of right second arm	151
Length of left second arm	150
Length of right third arm	114
Length of left third arm	127
Length of right ventral arm	91 +
Length of left ventral arm	127
Length of umbrella between dorsal arms	28
Length of umbrella between ventral arms	18

The only specimen seen is a small female (S.S.B. 399). Nevertheless, it presents so remarkable a combination of characters that there seems little risk in describing it as new. It necessarily recalls the *Pinnocotopus cordiformis* (Quoy and Gaimard) of New Zealand, but in that species the body is said to be tuberculated, and the arms are of nearly equal length. Moreover, the Kermadec specimen possesses no trace of the conspicuous blue lunulations along the arms as described for *P. cordiformis*—in fact, seems to have very little in common with the latter species save the remarkable development of the peripheral fold. In the smooth elongate body and predominating dorsal arms it approaches very closely the condition found in *P. macropus* (Risso), and this may prove something more than a mere coincidence.

Polypus sp. (young).

Two very juvenile *Polypi* in the collection (S.B.B. 404) may possibly represent young stages of *P. kermadecensis*. They are characterized by their very slender arms, and elongate light-coloured body terminating posteriorly in a sort of papilla, thus strongly recalling young specimens of *P. macropus* and perhaps *P. ornatus* of similar size. They lack the peripheral fold.

Fam. ONYCHOTEUTHIDAE Gray, 1849.

Genus ONYCHOTEUTHIS Lichtenstein, 1818.

Onychoteuthis banksii (Leach, 1817) Férussac, 1826.

Loligo banskii Leach, 1817, p. 141. *Onychoteuthis banskii* Férussac in d'Orbigny, 1826, p. 151.

The collection contains one adult and five immature specimens of this widely distributed species (S.S.B. 401). The right tentacle-club of the largest specimen has 10 hooks in the dorsal row and 11 in the smaller ventral row, the basalmost hook in this row being conspicuously larger than the others. There are 8 suckers and 7 pads in the fixing-apparatus. The left tentacle-club of the second largest specimen has 11 hooks in the dorsal row, 10 hooks in the ventral row, and 9 suckers and 5 pads in the fixing-apparatus. The other tentacle-club in each case is missing.

Fam. LYCOTEUTHIDAE n. n.

Thaumatolampadidae Chun, 1903, p. 68. *Onychoteuthidae* subfam. *Lycoteuthinae* Pfeffer, 1908, p. 294.

Genus NEMATOLAMPAS Berry, 1913.

Nematolampas Berry, 1913, p. 208.

A group allied to *Lycoteuthis* Pfeffer, 1900 (*Thaumatolampas* Chun, 1903), but with photogenic organs near the tips of the four dorsal arms and along the entire length of the third pair, which are highly modified, their tips being continued as very long and slender filaments devoid of suckers. Of the 5 subocular organs the central organ is conspicuously the largest. There is a pair of photogenic organs at the posterior extremity of the body, situated one on either side just under the fins. As in *Lycoteuthis*, there are 8 intrapallial photophores and 2 others of simple structure in the stalk of each tentacle.

Type.—The following species.

Nematolampas regalis Berry, 1913. Plate IX, figs. 1 and 2.

Nematolampas regalis Berry, 1913, p. 208, fig. 1.

Body small, loliginiform; the mantle thick and fleshy, compressed above and below; outline cylindro-conic, widest and very slightly flaring anteriorly, tapering more or less gradually to the fins, thence more rapidly to the posterior extremity, which is rounded and conspicuously swollen on either side, due to the presence of a pair of large heavily pigmented photogenic organs, which have much the appearance of small eyes; each organ is embedded in a small swelling of tissue snugly lodged in the angle between

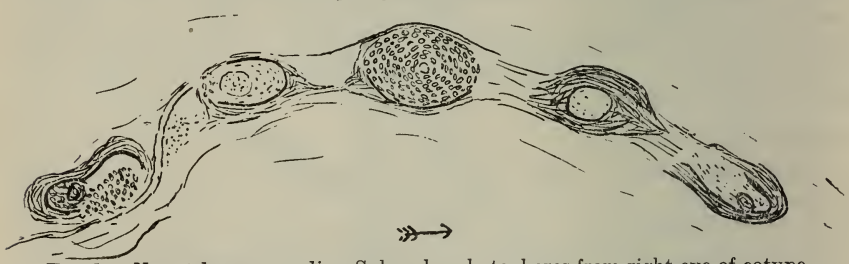


FIG. 1.—*Nematolampas regalis:* Subocular photophores from right eye of cotype. Freehand sketch from mount in balsam.

the fin and mantle, but so loosely adherent that it becomes readily dislodged after the fins have been loosened. Anterior mantle-margin with only a very slight angle dorsally, and a somewhat less obscure angle on either side of the funnel. Fins relatively very large, their combined width being about equal to the length of the body, though they are not quite half so long; anterior margins very thin, only slightly arcuate, and with a conspicuous notch next the body; posterior margins thicker and nearly straight, the outline of each fin thus forming an elongate (nearly) isosceles triangle, of which the lateral angle of the fin forms the apex. The fins are practically continuous with one another in the median line, at least posteriorly, and are very insecurely attached to the body.

Head relatively large, short, rounded, flattened above, somewhat excavated below. Eyes large and prominent. Ocular apertures large, with a slit-like sinus in front. Bordering the ventral periphery of each eyeball is a conspicuous series of 5 reddish bead-like photogenic organs. Of

Fig. 1. Dorsal View.

Fig. 2. Ventral View

Nematolampas regalis

[Face p. 140.]

Fig. 1. Dorsal View.

Fig. 2. Ventral View.

Abralia astrolineata.

these the central one is distinctly the largest, the anterior terminal one the smallest. To the naked eye the central organ appears to be nearly circular in outline, the organs on each side of it more oval, and the terminal organs quite elongate, but when the entire series is removed and mounted in balsam their outline as seen under a low-power lens is more as shown in the accompanying diagram (fig. 1). The large central organ is so conspicuous that it is visible through the outer integument even in preserved specimens. The funnel is short, compressed, and bluntly conical. Locking cartilages simple, comprising a slightly curved cartilaginous groove with raised margins on either side of the base of the funnel, and a very long and narrow ridge on the inner surface of the mantle, the ridge being about half again as long as the groove.

Arms very unequal in length, their relative order 3, 2, 4, 1, or perhaps 3, 2 = 4, 1. Dorsal pair notably the shortest and more slender than the others; not keeled except for a faint carination along their distal portions; each bears a single small heavily pigmented photogenic organ in the tissues of the outer portion of the arm, near the tip. Second-arm pair similar to the first, but larger and with a somewhat better-developed keel distally; each possesses a photogenic organ a little larger than

FIG. 2.

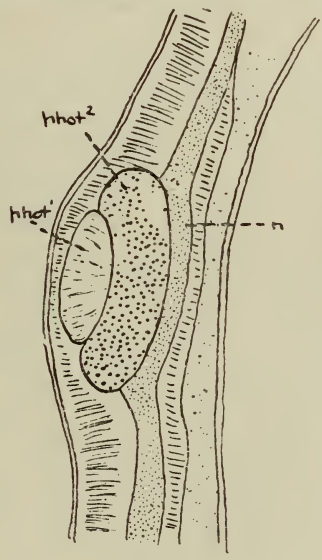


FIG. 4.

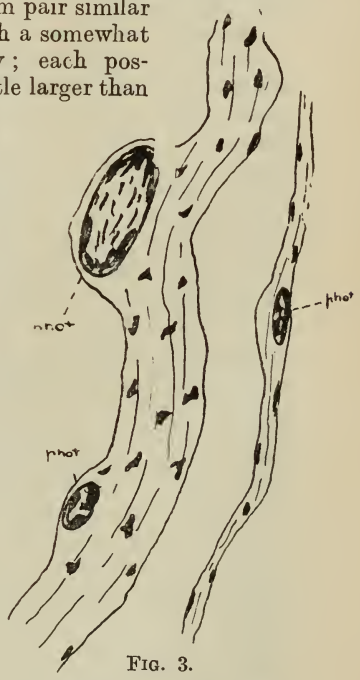


FIG. 3.

FIG. 2.—*Nematolampas regalis:* Right third arm of type, showing terminal filament and photogenic organs, the latter represented as small black dots.

FIG. 3.—*Nematolampas regalis:* Portions of terminal filament of right third arm of type, showing photogenic organs (the small dots in this drawing are chromatophores). Greatly enlarged freehand sketch from mount in balsam.

FIG. 4.—*Nematolampas regalis:* Portion of stalk of right tenacle of type, showing the large distal photogenic organ. Optical section from mount in balsam.

those of the dorsal arms, but otherwise similar. Third-arm pair stouter than any of the others and much the longest, terminating distally in an exceedingly slender beaded filament (fig. 2), which when straightened out is considerably longer than the entire remaining portion of the animal and is devoid of

suckers, though the arm proper is normal in this respect. The entire arm bears a succession of small photogenic organs scattered at various intervals along its outer margin, and similar in general appearance (though many of them are larger) to those near the tips of the first and second arms. On the filament these appear as swellings or tubercles often half again as large in diameter as the filament-stalk itself (fig. 3), but on the basal portion of the arm they become rather deeply embedded, and are not easily seen except by transmitted light. The basal portion, or arm proper, bears a heavy keel along its entire outer aspect, and traceable almost as far as the margin of the eye-lid. Including those borne on its terminal filament, the better-preserved arm of this pair carries a total of 31 photophores, of which 4 are in the keel. The ventral arms bear the usual fleshy fold along their outer margins, which is broadened at the base to form a sheath for the tentacle; they do not appear to possess photophores. Suckers minute, in 2 regularly alternating series on all the arms; 16 to 18 pairs are to be counted on the right third arm of one specimen, and 21 pairs on the right ventral arm. The sucker-bearing face of each arm has a delicate trabeculated membrane along either margin.

Tentacles stout; thick and fleshy at the base, thence tapering gradually to the club; laterally compressed; inner surface flattened. A very slight swelling is sometimes visible in the stalk a few millimetres from the base, which, when mounted in xylol or balsam so that it can be examined by transmitted light, is seen to mark the position of a small internal organ which is undoubtedly photogenic. A somewhat larger swelling, rendered more conspicuous by a thick aggregation of chromatophores on its outer margin, occurs a few millimetres proximad from the club. When cleared and mounted in balsam this is seen to mark the position of a much larger double photophore, embedded in the tissues just beneath the patch of chromatophores. In optical section (fig. 4) the organ shows an outer radially striate body (lenticular in longitudinal section) closely appressed within the concave surface of a much larger body, shaped like a shallow oval saucer (bean-shaped in longitudinal section). Both structures lie between the muscular layers of the tentacle-stalk and the central nerve-cord, each of which suffers a corresponding crowding and distortion. Tentacle-club little or not at all expanded; it is provided with a marginal web and armed with 4 rows of small suckers with toothed horny rings. I have been unable to make out the fixing-apparatus with sufficient clearness for description.

In addition to the numerous photogenic organs already noted, there are 8 others which are intrapallial, and therefore only visible in preserved specimens upon opening the mantle-chamber. The most anterior of these are the anal, a pair of small round greyish organs situated one on either side of the rectum just below the base of the funnel. A little to the rear of the middle of the visceral mass is a conspicuous half-circlet of 5 organs, the median one pale in colour, oval in outline, flattened, and unpaired; the two neighbouring organs in close juxtaposition to the central one, very large, likewise flattened and pale in colour. The terminal organs of the series are somewhat distant from the other three, one at the base of each gill, and have the appearance of small flattened tubercles set in pigmented cups. In the median plane of the body, considerably behind the centre of the fins, is a single large flat lozenge-shaped organ of a pale colour, in contact with which the tissues of the mantle are modified to form a conspicuous lens-shaped thickening similar to that described by Chun for *Thaumatolampas.*

Colour of specimens preserved in formalin a brownish buff dotted with numerous slate-coloured chromatophores which are very much more numerous dorsally than ventrally.

There are two specimens of this species in the collection, one of them well preserved (S.S.B. 409), the other fragmentary (S.S.B. 410). The former, which I have taken as the type, has furnished the greater part of the foregoing description, but the account of the subocular and intrapallial photogenic organs was drawn up from the second specimen.

Both specimens were picked up on the beach at Sunday Island in 1910 by R. S. Bell.

Measurements.	Type. mm.	Cotype. mm.
Length of body, dorsal	32	26·5
Tip of body to base of dorsal arms	41	33
Length of fins, extreme	15	10·5
Width of body	11	9
Width across fins	32	22
Width across eyes	11	9
Length of head	8	7·5
Length of funnel	..	6
Length of right dorsal arm	14	9
Length of left dorsal arm	14	12
Length of right second arm	17	13
Length of left second arm	18	14
Length of right third arm	75+	18+
Length of left third arm	50+	16+
Length of right ventral arm	17	12
Length of left ventral arm	17	12
Length of right tentacle	28	..
Length of left tentacle	25	..
Length of tentacle-club	8	..

This amazing little squid presents a very remarkable combination of characters, some of its features being, so far as I know, unique in the entire class *Cephalopoda*. Indeed, only two of all the described forms are even sufficiently similar for consideration in the same connection. These are the wonderful *Thaumatolampas diadema* of Chun (*Enoploteuthis diadema* Chun, 1900, p. 532, fig.: *Lycoteuthis diadema* Chun, 1903, p. 569, figs.: *Thaumatolampas diadema* Chun, 1903A, p. 67, &c.; 1910, p. 59, pl. 1–4) and the perhaps identical *Lycoteuthis jattai* of Pfeffer (1900, p. 161: *L. diadema* Pfeffer, 1908, p. 294; 1912, p. 113). *Enoploteuthis diadema* Chun, 1900, has precedence over *Lycoteuthis jattai* Pfeffer, 1900; whereas *Lycoteuthis* is in its turn prior to *Thaumatolampas* Chun, 1903. Pfeffer accordingly unites both forms under the name *Lycoteuthis diadema* (Chun); but, while in view of the evidence he gives there seems little doubt that the two genera are identical, it may be that the actual specific names will not prove to be synonyms. However that may be, *Lycoteuthis* is undoubtedly a very near ally of the form now before us, and the relation between the two is a most interesting one. Leaving out of consideration the extraordinary development of the third-arm pair, we find that, except in a few and relatively inconsequential details, no very special differences*

* Such differences appear in — (1) the order of length of the arms (2, 4, 3, 1 in *L. diadema*); (2) the fact that the central photophore of the subocular series is distinctly the largest in *Nematolampas*, whereas Pfeffer's figure of *Lycoteuthis* (1912, pl. 14, fig. 9) shows the two terminal organs as the largest; (3) the broader fins of the Kermadec species; &c.

obtain between *Nematolampas* and the specimens of *Lycoteuthis* until we come to a study of the distribution of the luminous organs. Even here we find that each and every such organ described by Chun for *L. diadema* finds its exact homologue in *Nematolampas*, but, continuing further, it appears that the Kermadec species possesses another entire battery of these "living lights" in addition. The comparison is well brought out in the following table :—

Position of Photophores.	*Lycoteuthis diadema.*	*Nematolampas regalis.*
Ventral periphery of eyeball (5 on each) ..	10	10
Tip of dorsal arms (1 on each)	..	2
Tip of dorso-lateral arms (1 on each) ..	..	2
Ventro-lateral arms (31+ on each)	..	62+
Tentacles (2 on each)	4	4
Within pallial chamber—		
Anal	2	2
Branchial	2	2
Abdominal	4	4
Posterior extremity of body	..	2
	22	90+

The complete homology of the complex intrapallial and tentacular photogenic systems of the two species, coupled with the fact that all the more important characters which differentiate *Nematolampas* (*i.e.*, not only the additional photophores, but the filamentous terminations of the third-arm pair) take the form of features, as it were, superadded to those already present in *Lycoteuthis*, at once suggests that in *Nematolampas* we have either a more advanced stage in the ontogeny of the older genus, or simply more perfect material. I do not believe that either hypothesis, however, is in accordance with all the facts. In the first place, the dimensions of the type of *L. diadema* as given by Chun exceed those of the smaller of the Kermadec specimens, and average only slightly less than those of the larger; in the second place, though the specimens before me are not at all of the same size, they do not differ in any essential particulars; and, in the third place, *L. diadema* was captured and observed in the living state by an investigator no less acute than Dr. Chun himself.

It will be noted from the above account that *Nematolampas regalis* possesses at least 90 definitely and symmetrically arranged photogenic organs, of which only 2 are unpaired, and it may be that there are yet others which have escaped my search, the opacity of the tissues in preserved material frequently rendering their detection exceedingly difficult. The 22 organs of *Lycoteuthis*, according to Chun, are constructed upon no less than ten *different principles*, and are adapted for the production of lights of several different colours and intensities. These ten types are all present in the species from the Kermadecs, with at least two more as well. As to the gorgeous appearance of this animal in life, we can only conjecture, although Chun's lively description of his species gives us a most tantalizing inkling of what we may expect. Cephalopods are bizarre creatures anyway, but no more astonishing member of the group than this has rewarded one of our collecting expeditions for a good many years.

Fam. ENOPLOTEUTHIDAE Pfeffer, 1900.

Genus ABRALIA Gray, 1849.

Abralia astrolineata n. sp. Plate X, figs. 1 and 2.

Mantle cylindro-conical, broadest anteriorly; tapering but slightly for about half its length, thence rapidly, and then more gradually again to a rather blunt point, the presence of 3 faint light-coloured swellings or tubercles (one median and very indistinct, the others lateral, slightly more conspicuous, and situated close up under the base of the fins) giving rise to a general swollen appearance just in front of the actual tip. Anterior mantle-margin with only a slight obtuse median angle dorsally, and somewhat more acute lateral angles below on either side of a shallow emargination under the funnel. Fins large, broadly triangular; about three-sevenths as long as the body, their combined width about three-fourths the length of the body; anterior margins slightly arcuate, with a conspicuous notch next the body; posterior margins slightly concave, and barely produced posteriorly to include the tip of the body.

Head squarish, flattened above, excavated below. Ocular apertures very large, their margins with only a faint obtuse angle in front in place of the usual sinus. Funnel broadly triangular; swollen below; squarish at the extremity.

Arms about two-thirds as long as the body; unequal, the order of relative length 4, 2, 3, 1; dorsal arms a little more slender than the others, rounded at the base, but with traces of a keel distally; second-arm pair angular and weakly keeled, third pair more so; ventral arms with a broad keel along their outer margins forming the usual sheath at the base for the tentacles; "swimming membranes" present on all the arms, the ventral membrane of the third pair being especially well developed. Each arm is equipped with 2 rows of small hooks, but on all, even the ventral pair, these are succeeded by true suckers on the distal portions, though the latter are notably fewer on the ventral arms than on the others.

Tentacles long and rather slender; club little expanded, and armed over the distal half of its inner face with 4 rows of very minute suckers, replaced proximally by a single row of sharp and slender hooks, with 2 series of wide-mouthed suckers opposite. The left tentacle-club of the present specimen (which is better preserved than its mate) shows the rows of hooks to comprise 1 small proximal hook succeeded by 4 larger ones, while the suckers of the outermost series are notably larger than those corresponding in the inner row. The carpal fixing-apparatus contains 5 small suckers, the proximal one excessively minute, and a probably similar group of pads, the exact number of which I have been unable to determine. On the right tentacle there appear to be but 4 suckers in the fixing-apparatus and only 4 hooks on the club. The horny rings on the largest tentacular suckers are armed with some 27–29 round-pointed teeth.

The photogenic organs are very numerous, and their somewhat unusual distribution may be briefly outlined as follows, according to the regions of the body which they occupy.

A. *The Mantle.*

1. *Ventral Aspect.*—Here the arrangement of the numerous luminous organs shows an essential bilateral symmetry throughout. The entire medio-ventral line of the body is marked by a narrow clear space, slightly broadening posteriorly just before reaching the tip of the body, and devoid of photophores. Defining the clear strip on either side are 2 conspicuous

multiple bands of round bluish photophores (4 bands in all), of which the inner pair are the most regular, persist farthest posteriorly, and are the broader, including a central series of comparatively large distant organs flanked on each side by a more numerous series of smaller and darker ones. Lateral to these 4 bands on each side is a somewhat irregular single series of small organs, with traces of at least 2 similar rows beyond this. In all these lateral series the photophores exhibit a curious tendency to lie in longitudinal groups of three, the median organ of which is in each case the largest. The differentiation of the organs into those of a larger and a smaller type is evident as in other species, but not conspicuous, and there are many of various intermediate conditions.

2. *Dorsal Aspect.*—A single series of very minute distant organs extends along the dorsum close to the gladius on either side. There are a few scattered organs, apparently traces of other longitudinal rows, here and there over the remainder of the dorsal surface.

B. *The Funnel.*

Four series (or, better, groups) of photophores similar to those of the mantle occur on the ventral aspect of the funnel. They are well separated, the two median groups being closer to one another than either is to its lateral neighbour.

C. *The Head and Arms.*

1. *Ventral Aspect.*—Here there are 3 conspicuous biserial to triserial bands of organs, of which the median is the broadest, at least posteriorly, where it bifurcates into 2 triangular groups; one of the larger type of organs occurs at the point of bifurcation and another in the centre of each group. Anteriorly the median band becomes single and again bifurcates, the 2 resulting series extending along the inner margin of each ventral arm not quite to its extremity. The lateral bands likewise extend along the ventral arms, running out their outer margins to the tips Lateral to all these on each side is a single series of the organs; this series is interrupted by the clear area overlying the large subocular photophores, but thereafter continues along the outer edge of the membrane bordering the ventral arms, so that in all there are 3 rows of photogenic organs on each member of this arm pair. A circlet of photophores borders the aperture of each eyelid, and there is a single series of some 4 or 5 of the organs on the outer angle of the basal portion of the third arms.

2. *Dorsal Aspect*—I have been unable to detect the presence of photogenic organs on the dorsal surface of the head, or on any of the dorsal or dorso-lateral arms.

D. *The Tips of the Ventral Arms.*

A series of 3 very minute but heavily pigmented organs is to be made out at the tip of each ventral arm. They are not conspicuous, are too small to be designated even as "swellings," and would be apt to escape an unwary examination.

E. *Eyes.*

A longitudinal series of 5 large round bead-like organs is borne on the ventral periphery of each eyeball. They are of a dark-red colour, the centre paler, and are very similar in size and appearance. The three central organs are so close together as to appear almost in contact, but each terminal organ is set off by a slight space.

Colour of the entire animal a brownish buff, dotted above with numerous scattered brownish chromatophores. On the dorsal aspect of the head the

latter are more numerous than anywhere else, and mostly gathered in 2 large, dark, and very conspicuous triangular patches, one over each eye. There are chromatophores on the ventral surface, but owing to their larger size and more definite arrangement the bluish slate-coloured photogenic organs are much more conspicuous. The keel of the gladius is very plainly evident through the dorsal integument as a sharp and prominent dark line. The buccal membrane is pale, its outer surface beautifully dotted with reddish-brown chromatophores.

The type and only specimen seen is a female (S.S.B. 408). It is a remarkably well-preserved beach specimen, collected by R. S. Bell in 1910.

Measurements.	mm.
Total length	90
Length of mantle, dorsal	34
Tip of body to base of dorsal arms	42
Extreme length of fins	15
Width of body	11
Width across fins	26
Width across eyes	11
Length of right dorsal arm	19
Length of left dorsal arm	19
Length of right second arm	22
Length of left second arm	22
Length of right third arm	20
Length of left third arm	20
Length of right ventral arm	24
Length of left ventral arm	23
Length of right tentacle	40
Length of left tentacle	48
Length of tentacle-club	7

In its general organization *A. astrolineata* represents a type so different from all other *Abralias* as to scarcely require any special comparison with any of them. Its most conspicuous distinctive feature is undoubtedly to be found in the beautiful banded arrangements of the photogenic organs on the ventral surface of the mantle, but an even more interesting feature appears in the structure of the ventral arms. These show a condition almost exactly intermediate between the highly modified ventral-arm tips of *Abraliopsis* and the normal state of affairs in *Abralia*, thus in large degree tending to break down in a most important particular the distinction between the two groups. While the ventral arms in this species bear true suckers at their extremities, differing from those of the other arms in no (apparent) essential particular save their smaller number, each bears at its very tip a series of 3 very minute heavily pigmented photophores, which, despite their poorer development, are very obviously homologous with the curious swollen terminal photophores of *Abraliopsis*. As in the latter genus also, there are but 3 rows of photogenic organs along the basal portion of the ventral arms, although the buccal membrane and tentacular armature are those of the usual *Abralia*. The reader has perhaps noticed that in a number of particulars *A. astrolineata* agrees very curiously with *A. astrosticta* of the Hawaiian Islands; but it has nevertheless a totally different aspect, and undoubtedly belongs to another group, the much larger fins and different distribution of the pallial photogenic organs being among the more obvious differences. The latter structures are also more numerous and much less conspicuously dimorphic than in *astrosticta*.

What may be the nature of the lateral swellings observed near the posterior tip of the body, and whether they may in any way be homologized with the photogenic organs which occupy an analogous position in *Nematolampas*, I have been unable to determine.

Genus Abraliopsis Joubin. 1896.

? **Abraliopsis hoylei** (Pfeffer, 1884) Joubin, 1896.

Enoploteuthis hoylei Pfeffer, 1884, p. 17, fig. 22. *Abraliopsis hoylei* Joubin, 1896, p. 33, &c. *Abraliopsis hoylei* Hoyle, 1904, p. 36, pl. 1, fig. 3 ; pl. 8 ; pl. 10, figs. 1–10.

The single specimen sent me (S.S.B. 400) is perhaps not quite adult, so that I refer it to this species with considerable uncertainty, more especially since Pfeffer (1912, pp. 152, 160) has recently expressed the opinion that the Panamic specimens described by Hoyle represent a previously unnamed species which he designates as *A. affinis*.

The left tentacle-club of this specimen is missing, but the right club has 5 suckers and 5 pads in the fixing-apparatus, and 2 rows of hooks succeeded distally by the usual 4 rows of small suckers. The ventral row of hooks consists of 4 large hooks with a single very minute sucker proximal to them in the same row. The dorsal row contains a similar small proximal sucker, succeeded by 3 (+ one missing ?) small hooks.

The specimen was collected on one of the beaches by R. S. Bell in 1910.

Fam. OMMASTREPHIDAE Gill, 1871.

Genus Sthenoteuthis Verrill, 1880.

Sthenoteuthis bartramii (Lesueur, 1821) Verrill, 1880.

Loligo bartramii Lesueur, 1821. p. 90, pl. 7. *Sthenoteuthis bartramii* Verrill, 1880, p. 223.

Three specimens in the present collection (S.S.B. 407) serve to extend still further the wide area of ocean already known to be inhabited by this species. They were cast up on Denham Bay beach, and collected at various times during 1908 by Mr. T. Iredale.

Genus Symplectoteuthis Pfeffer, 1900.

Symplectoteuthis oualaniensis (Lesson, 1830) Pfeffer, 1900.

Loligo oualaniensis Lesson, 1830, p. 240, pl. 1, fig. 2. *Symplectoteuthis oualaniensis* Pfeffer, 1900, p. 180 ; 1912, p. 502, pl. 40, 41 ; pl. 42, figs. 1–4.

The three specimens here referred to the present species are all immature, the largest having a medio-dorsal mantle-length of only 44 mm. ; but all show the characteristic adhesion of the mantle to the locking cartilages of the funnel on both sides (S.S.B. 402).

Collected on the beaches in 1910 by R. S. Bell.

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EXPLANATION OF PLATES.

PLATE VII.

Polypus kermadecensis, ♀: Dorsal view of type; about natural size.

PLATE VIII.

Polypus kermadecensis, ♀: Ventral view of type; about natural size.

PLATE IX.

Fig. 1.—*Nematolampas regalis*: Dorsal view of type; about twice natural size.

Fig. 2.—*Nematolampas regalis*: Ventral view of type; about twice natural size.

Because of their brittle condition, it proved impossible to straighten out the filamentous tips of the third-arm pair as completely as necessary to properly indicate their great length.

PLATE X.

Fig. 1.—*Abralia astrolineata*, ♀: Dorsal view of type; somewhat less than twice the natural size.

Fig. 2.—*Abralia astrolineata*, ♀: Ventral view of type; same scale as preceding.

Art. XXV. — *An Ecological Study of some New Zealand Sand-dune Plants.*

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Communicated by Dr. Charles Chilton.

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A. Introduction.

The work of Warming (1895) and of Schimper (1898) gave an impetus to the study of plant-ecology, and led to the publication of a considerable amount of literature on the subject, and ecology is now recognized as an important branch of botanical science. Previous to the year 1909 there has not been much published regarding the ecology of New Zealand sand-dune plants, the subject treated of in this paper. Various papers, mostly floristic, in the "Transactions of the New Zealand Institute" have dealt with or referred to the sand-dunes or littoral districts of various parts of New Zealand, and lists of species, generally incomplete, have been there included. For example,—

J. B. Armstrong, in "A Short Sketch of the Flora of the Province of Canterbury, with Catalogue of Species" (Trans. N.Z. Inst., vol. 12, p. 325), mentions some of the dominant plants of the littoral district of Canterbury Province, and in his list of species (grouped in families) he gives the locality in which the plants are found.

J. Buchanan, in his "List of Plants found on Miramar Peninsula, Wellington Harbour" (Trans. N.Z. Inst., vol. 1, p. 349), gives a list of some eighty-two species (belonging to fifty-two genera) of plants of swamp, sand-dune, and seaside botanical regions, which plants, he says, "having here an estuarine relation, may be grouped as one; spreading, as many of the species do, over the whole district, it would be difficult to separate them on the experience of this locality alone."

J. Buchanan and T. Kirk give a "List of Plants in Northern District of the Province of Auckland" (Trans. N.Z. Inst., vol. 2, p. 239). The plants are not grouped according to their environment, but the locality of each species is given.

H. Carse, in his articles "On the Flora of Mangonui County" (Trans. N.Z. Inst., vol. 43, p. 194) and "On the Flora of the Mauku District" (vol. 34, p. 362), gives lists of plants, and includes a short description of plants of sandhills, mentions some of the chief plants, and gives a catalogue of the flowering-plants and ferns of the districts studied, the plants being grouped in their families, and the environment of each species being mentioned.

T. Kirk, in his article "On the Botany of the Thames Goldfield" (Trans. N.Z. Inst., vol. 2, p. 89), mentions about thirty-six species of plants of the

littoral district of the field observed ; in "Notes on the Botany of certain Places in the Waikato District" (Trans. N.Z. Inst., vol. 3, p. 142) and "On Flora of Isthmus of Auckland and the Takapuna District" he mentions a few coastal plants.

D. Petrie, in an article entitled "A Visit to Stewart Island, with Notes on its Flora" (Trans. N.Z. Inst., vol. 13, p. 323), gives a description of the various localities, with plants found there, and a list of plants grouped in families, not according to environment. D. Petrie also gives a "List of the Flowering-plants indigenous to Otago, with Indications of their Distribution and Range in Altitude" (Trans. N.Z. Inst., vol. 28, p. 540), and in this list shore-plants are included.

W. Townson, "On the Vegetation of the Westport District," includes in his description of the district a list of plants (grouped in families), with a brief description of their environment (Trans. N.Z. Inst., vol. 29, p. 380).

W. T. L. Travers, in his "Remarks on the Sand-dunes of the West Coast of the Provincial District of Wellington (Trans. N.Z. Inst., vol. 14, p. 89), gives a list of the principal plants found on the sand-dunes of New Zealand.

L. Cockayne has several articles published in the "Transactions of the New Zealand Institute," in which dune-ecology received for the first time some attention ; but his "Report on the Sand-dunes of New Zealand," published in 1909, gives the first comprehensive account of the sand-dune plants of New Zealand. In 1911 an enlarged edition of this work appeared, giving an account of the geology, botany, and reclamation of the dune areas of New Zealand. Cockayne has given a general description of the sand-dune flora of New Zealand, including a list of the species, in families, with the distribution and growth-form of each, and grouping the dominant species in plant associations according to their origin and relationships. Such a general description, though comprehensive, is not intended to be exhaustive or detailed, and no attention is paid to plant-anatomy.

Any one species living in any plant association or region has its own special conditions, apart from those of the habitat in general, and may not show the characteristics of a typical denizen of that plant association. Indeed, its anatomy may reveal characters quite unsuited to the general habitat: for instance, although a sand-dune flora is typically xerophytic certain species perhaps will not show xerophytic characters. Each individual species must therefore be examined in detail, to show how far its habit and structure correspond with, or differ from, those typical of the vegetation in which it is found.

The present paper, then, is intended to supplement Cockayne's account of the botany of New Zealand dune-plants, and to give such attention to individual species as is required to extend our knowledge of the life requirements of certain plants mentioned or described in the above report.

B. FIELD OF OBSERVATION.

Description of Aspect and Plant Covering of the Dunes observed.

The sand-dunes selected for examination are those of the seashore at New Brighton, Canterbury, and form a portion of that large area of sand which extends from the Sumner Estuary to the Waimakariri River.

Extending along the greater part of the beach is a ridge of sand—the foredune—fixed to a great extent naturally, and in part artificially, by the native pingao (*Scirpus frondosus*) and the introduced marram-grass (*Ammophila arenaria*).

Inland from the foredune are—(1) unstable dunes; (2) dune-hollows; and (3) sand-plains.

For purposes of description, the beach may be divided into two portions—(1) the south beach, extending from the New Brighton pier to the Sumner Estuary; (2) the north beach, reaching north from the pier towards the River Waimakariri.

The south portion is fronted all along by a prominent foredune, inland to which is a small extent of dune. Farther inland still are found stable sand-plains. At the extreme end, near the estuary, are found moist sand-hollows.

At the north end of the beach there is an artificial foredune for some distance from the pier; farther north there is no foredune. Here the dunes extend farther inland than those of the southern beach; the gently undulating dune-land nearest the shore has little plant covering, the pingao (*Scirpus frondosus*) being here, as usual on the active dune, the dominant species. Farther inland the dunes are higher and the hollows deeper; and after rainfall there are numerous lakes, some of which dry up, but others appear stagnant, and have a rich vegetation.

List of Indigenous Species found on the Sand-dunes, New Brighton.

[N. refers to northern beach, S. to southern.]

Species, Family, &c.	Habitat.
FILICES.	
Pteridium esculentum (Forst. f.). Cockayne (common bracken fern)	Heath, plain. S.
GRAMINEAE.	
Calamagrostis Billardieri (R. Br.) Steud. ..	Active dune, sand-hollow. N.
Arundo conspicua Forst. f. (toetoe) ..	Stable dunes or shrub dunes. N. and S.
Poa caespitosa Forst. f. (tussock-grass) ..	Dunes, active or semi-stable. N. and S.
Festuca littoralis Labill. (tussock-grass) ..	Active dunes. N. and S.
CYPERACEAE.	
Scirpus nodosus (R. Br.) Rottb.	Dunes, plain, hollows. N. and S.
—— *frondosus* Banks & Sol. (pingao) ..	Foredune, active dune. N. and S.
Schoenus concinnus (Hook. f.) Cheesem. ..	Sand-hollow.
Carex pumila Thunb.	Moist sand-hollow. N. and S.
RESTIONACEAE.	
Leptocarpus simplex A. Rich.	Plains, hollows, swampy places. N. and S.
JUNCACEAE.	
Juncus maritimus Lam. var. *australiensis* Buch.	Moist hollow, wet places. N. and S.
LILIACEAE.	
Phormium tenax Forst. (N.Z. flax)	Shrub dune only. N.
RANUNCULACEAE.	
Ranunculus acaulis Banks & Sol.	Sand-hollow. S.
ROSACEAE.	
Acaena novae-zealandiae T. Kirk (piripiri) ..	Stable plains. N. and S.
Potentilla anserina L. var. *anserinoides* (Raoul) T. Kirk	Stable plains. N. and S.
LEGUMINOSAE.	
Carmichaelia subulata T. Kirk (native broom)	Shrub dune.

List of Indigenous Species found on the Sand-dunes, New Brighton—continued.

Species, Family, &c.	Habitat.
LINACEAE.	
Linum monogynum Forst. f. (white flax) ..	Active dunes. N. and S.
RHAMNACEAE.	
Discaria toumatou Raoul (wild-irishman) ..	Active dunes, sand-plains. N. and S.
VIOLACEAE.	
Viola Cunninghamii Hook. f. (N.Z. violet) ..	Dunes. S.
THYMELAEACEAE.	
Pimelea arenaria A. Cunn.	Active dune. S.
MYRTACEAE.	
Leptospermum scoparium Forst. (manuka) ..	Shrub dune, plain; wet places. N. and S.
ONAGRACEAE.	
Epilobium Billardierianum Ser.	Moist sand-hollows. N.
—— *nerterioides* A. Cunn.	Moist sand-hollows. N. and S.
HALORRHAGACEAE.	
Gunnera arenaria Cheesem.	Moist hollow. N.
UMBELLIFERAE.	
Hydrocotyle tripartita R. Br.	Moist hollow. N.
Apium prostratum Labill.	Sand-hollow. N.
Crantzia lineata Nutt.	Moist hollow. N.
PRIMULACEAE.	
Samolus repens (Forst.) Pers. var. *procumbens* R. Knuth	Moist hollow. N.
CONVOLVULACEAE.	
Calystegia Soldanella (L.) R. Br. (shore convolvulus)	Active dunes. N. and S.
SCROPHULARINACEAE.	
Mazus pumilio R. Br.	Moist hollow. N.
MYOPORACEAE.	
Myoporum laetum Forst. f. (ngaio)	Only one tree was found, on the active dunes south. This is one of the rare occurrences of the species on the active dune referred to by Cockayne in his report, 1911, p. 40.
RUBIACEAE.	
Coprosma acerosa A. Cunn.	Active dunes, shrub dunes. N. and S.
GOODENIACEAE.	
Selliera radicans Cav.	Moist hollows. N. and S.
COMPOSITAE.	
Gnaphalium luteo-album L.	Shrub dunes and sand-hollows. N. and S.
Cassinia fulvida Hook. f.	Active dunes, shrub dunes, heath. N. and S.
Cotula dioica Hook. f.	Moist hollow. N. and S.
Senecio lautus Forst. f. var. *a*	Active dunes. N. and S
Sonchus littoralis (T. Kirk) Cockayne ..	Active dunes. N. and S.

Many introduced plants are found, especially in the stable sand-plain. The tree-lupin (*Lupinus arboreus* Sims) covers extensive patches on dune and plain.

Of the forty or so indigenous species found in the field examined, seventeen were selected for anatomical observation, namely,—

(*a.*) Gramineae.

1. *Calamagrostris Billardieri.*
2. *Arundo conspicua.*
3. *Poa caespitosa.*
4. *Festuca littoralis.*

(*b.*) Cyperaceae.

5. *Scirpus nodosus.*
6. —— *frondosus.*
7. *Carex pumila.*

(*c.*) Restionaceae.

8. *Leptocarpus simplex.*

(*d.*) Thymelaeaceae.

9. *Pimelea arenaria.*

(*e.*) Myrtaceae.

10. *Leptospermum scoparium.*

(*f.*) Onagraceae.

11. *Epilobium Billardierianum.*
12. —— *nerterioides.*

(*g.*) Halorrhagaceae.

13. *Gunnera arenaria.*

(*h.*) Umbelliferae.

14. *Crantzia lineata.*

(*i.*) Convolvulaceae.

15. *Calystegia Soldanella.*

(*j.*) Rubiaceae.

16. *Coprosma acerosa.*

(*k.*) Compositae.

17. *Cassinia fulvida.*

C. Ecological Conditions of the Dune-plants.

Full details as to New Zealand dune conditions are not necessary here, since they are treated of at length by Cockayne ("Report on the Dune Areas," p. 19 *et seq.*).

Some of the more important factors, however, governing the form, &c., of the dune-plants are as follows :—

1. *Edaphic.*

(*a.*) Moderately fine quartz sand.

(*b.*) Moisture available at all times except for first 5 in. of surface of hills.

(*c.*) Hollows much wetter than hills, owing to proximity to water-table, so that water may lie in pools on the surface for considerable periods, especially in winter.

(*d.*) Layer of humus in many places, at some yards deep in the hills, but forming an upper thin soil in some of the hollows.

(*e.*) Lack of nutritive salts.

2. *Climatic.*

(*a.*) Prevalent winds at New Brighton: (1) East, from sea ; (2) north-west, hot and dry ; (3) south-west, cold and often bringing rain.

(*b.*) Effect of wind : (1) Blows sand, thus plants are liable to be buried, and liable to mechanical damage from drifting sand ; (2) cools soil, and causes rapid evaporation ; (3) transpiration accelerated.

(*c.*) Insolation strong.

(*d.*) Heating of surface sand intense at times, but substratum where moist quite cool at few inches below surface.

(*e.*) Frosts are comparatively severe from June to August, $-10°$ C. having been frequently recorded; shallow-rooting plants would therefore be subject to lack of water.

When considering the structure of the dune-plants it must not be forgotten that the hills and hollows, as shown in the above table, offer different conditions, the hills demanding not only a more xerophytic structure than do the hollows, but a tolerance of blown sand on the part of the plants.

In connection with the amount of salt in the sand of the dunes, it must be noted that T. H. Kearney, in "Are Plants of Sea-beaches and Dunes True Halophytes?" finds that the sea-beach sand contains a very small quantity indeed of salt; therefore the sand-dune plants of the seashore are not halophytic.

D. PLANT DESCRIPTIONS.

1. Calamagrostis Billardieri.

(*a.*) *Habitat.*

Found in both active dunes and sand-hollows at the northern portion of the beach.

(*b.*) *General Form.*

A tufted grass, growing in green patches longer than broad, about 8 in. to over 1 ft. high.

Leaves shorter than the culms, about $\frac{1}{4}$ in. broad, striate, flat, dorsal surface ridged and furrowed, bright green, sheathing, spreading semi-vertically, tapering to a point.

Rhizome slender, creeping, with many roots.

(*c.*) *Leaf-anatomy.*

Epidermis: Dorsal—In transverse section, large round cells on the ridges, five or six very large bulliform cells at the bottom of the furrows; stomata with subsidiary cells, sunken air-spaces beneath. Ventral—In transverse section, large cells, those beneath the mestome bundles projecting, thus forming an irregular surface; in surface view, long cells alternating with short cells, which sometimes appear as papillae; cell-walls thick, not undulating.

Chlorenchyma: Bands, butterfly-shaped in transverse section, alternate with mestome bundles; cells of irregular shape, rounded or polygonal, with small intercellular spaces.

Stereome in small subepidermal patches above and beneath the mestome bundles.

Fibro-vascular bundles of ordinary monocotyledon structure, xylem with two large pitted vessels and smaller elements, and a patch of phloem; the bundle surrounded by a sheath with thickened inner walls, and a parenchyma sheath sometimes colourless, sometimes containing chlorophyll-grains. Above and below the bundles there are often small groups of colourless parenchyma cells, adjoining the stereome, and probably functioning as water-storage cells. The bundles, together with the stereome and water-parenchyma, separate the bands of chlorenchyma.

(*d.*) *Conclusion.*

Contrary to what might be expected from the fact that this plant frequently grows in an exposed position on the active dunes, leaf-anatomy shows structure far from xerophytic. There is a small amount of stereome and of water-parenchyma, the epidermal walls are thick, but otherwise the leaf is mesophytic. It is flat and green and thin, and the frequent stomata are not well protected.

Calamagrostis also grows in dune-hollows, where xerophytic characters are not so necessary, owing to the greater amount of moisture and protection from winds.

2. Arundo conspicua.

(*a.*) *Habitat.*

Rarely occurs on the southern portion of the New Brighton beach—*i.e.*, between the pier and the Sumner Estuary; more common on the north beach, towards Belfast, where it is found some distance inland, where the dunes are comparatively stable. Elsewhere a denizen of both swamp and heath; therefore a plant of very different stations, though a swamp may be xerophytic.

(*b.*) *Growth-form.*

A very conspicuous grass, tall, often reaching a height of as much as 11 ft.; forms large dense tussocks; inflorescences characteristic.

Leaves long, relatively narrow, coriaceous, flat or involute, veins plainly seen, ridged and furrowed.

Inflorescence a showy panicle, yellowish-white, silky, 1–2 ft. long, thickly branched, spikelets very numerous.

Rhizome stout; can grow upwards to some extent as buried.

(*c.*) *Leaf-anatomy.*

Epidermis: On exposed surface, a cuticle; regular rectangular cells, elongated in direction of the leaf-axis, alternating with small cells; cell-walls thick, wavy; a few stomata. On inrolled surface, cells elongated, cell-walls thin, stomata numerous in the furrows, subsidiary cells present, epidermal cells commonly rounded, and with outer walls much thickened.

Chlorenchyma in bands alternating with vascular bundles, reaching to both surfaces of the leaf; water-parenchyma in the midst of each chlorenchyma band. Cells more or less polygonal; air-spaces beneath stomata.

Stereome present in subepidermal patches, sometimes extending from the surface to the vascular bundles. The stereome immediately beneath the epidermis consists of much smaller cells than that adjacent to the bundles.

Fibro-vascular bundles, together with stereome, separate bands of chlorenchyma; of typical monocotyledon structure; sheath with thickened inner walls, surrounded by parenchyma sheath.

(*d.*) *Conclusion.*

Arundo conspicua shows marked xerophytic characters — viz., inrolled leaf, stomata in furrows and mostly on protected side of the leaf, water-parenchyma, and stereome. The growth-form, the tussock, also is xerophytic. Its tall habit in all positions obviously exposes it to the full force of the wind. On the other hand, its tussock form shelters the inner leaves, and combats transpiration.

3. Poa caespitosa.

(*a.*) *Habitat.*

Found on active dunes, often just inland to the foredune; also at times in dune-hollows. Confined to the dune area.

(*b.*) *Growth-form.*

A grass forming close yellowish-green tussocks, 1½–3 ft. high. Very like *Festuca littoralis* in external appearance, but can be distinguished by the inflorescence and less rigid leaves.

Leaves narrow, so strongly involute as to be nearly terete, smooth, pale green or yellowish, ending in fine sharp points.

Inflorescence a panicle, fine, lax; stalks slender; branches few, in distinct clusters.

(*c.*) *Leaf-anatomy.*

Leaf-margins meeting above midrib. From the small opening between the margins to the midrib extends a narrow fissure, with a furrow on each side of the midrib, reaching more than half-way to the dorsal surface of the leaf.

Epidermis: Exposed surface—elongated rectangular cells alternating with smaller cells; walls thick, undulating; no stomata; thick cuticle. Inrolled surface—cell-walls thinner than on exposed surface, elongated in surface view; stomata frequent between the bands of subepidermal stereome, regularly arranged with stomatal clefts parallel with leaf-axis; subsidiary cells present. Stomata sunk beneath the surface. Epidermal cells rounded, and with outer wall much thickened; many epidermal cells smaller than the ordinary ones, and prolonged into simple hairs with thick walls, forming a fairly close covering to the inrolled surface of the leaf.

Chlorenchyma arranged in bands, alternating with fibro-vascular bundles and stereome. Cells relatively small, polygonal, close-packed, undifferentiated, thick-walled; air-spaces beneath stomata; the chlorenchyma bands reach the inrolled surface, but are usually separated from the exposed epidermis by stereome.

Stereome well developed, in thick bands above and below the vascular bundles, extending to both surfaces; stereome extends all along the exposed epidermis.

Fibro-vascular bundles arranged regularly, alternating with chlorenchyma bands, of typical monocotyledon structure; two large pitted vessels, a few smaller spiral or annular vessels, and a lysigenous cavity; sheath of colourless parenchyma enclosing mestome sheath with thickened inner walls.

(*d.*) *Conclusion.*

Poa caespitosa shows the following xerophytic characters: Tussock form, involute leaf, protected surface hairy; stomata on protected surface only, and sunken; homogeneous chlorenchyma of thick-walled polygonal cells, and well-developed stereome.

It is interesting to note the extra wall-thickening of the chlorenchyma as compared with that of the apparently more xerophytic *Festuca littoralis*. *Poa caespitosa* is a characteristic plant of tussock-steppe, and not a special dune-plant.

4. **Festuca littoralis.**

(*a.*) *Habitat.*

Found commonly all along the dunes, sometimes on the foredune among *Scirpus frondosus*, and rarely, even on the shore, in front of the foredune, where, so far as New Brighton is concerned, the only other vegetation is the introduced succulent cruciferous plant *Cakile maritima.*

(*b.*) *Growth-form.*

Forms close-growing yellowish-green tussocks, usually 2–3 ft. high, and measuring about 5 in. through at the base; several small tussocks commonly grow together, so that the whole clump measures more than 1 ft. through at the base. Very like *Poa caespitosa*, but can easily be distinguished by the inflorescence.

Roots many, long, spreading, covered with rootlets.

Leaves narrow, strongly involute, appearing almost cylindrical, ending in a point, smooth, shining, pale green or yellowish.

Inflorescence a panicle, long, dense, narrow, spike-like, with broad spikelets.

(*c.*) *Leaf-anatomy.*

Leaf-margins almost meeting above the midrib, and hence only one surface exposed. From the slight opening between the margins to the midrib extends a narrow fissure, with lateral furrows between the veins, reaching two-thirds of the way to the exposed surface of the leaf. The ridges above the vascular bundles between these furrows are broad and rounded.

Epidermis: Inrolled surface—cell-walls undulate, cells elongated, many cells smaller but extended into straight or curved spreading unicellular hairs which line the main cavity and lateral furrows with a dense crosswork; stomata numerous in the furrows, clefts in direction of leaf-axis, subsidiary cells present. Exposed surface—long rectangular cells alternating with short cells; cell-walls more undulating than on the other surface; no stomata; waved cuticle.

Hypodermis present beneath epidermis of exposed surface, consisting of one or two layers of small thick-walled cells, merging gradually into the thick-walled colourless parenchyma which surrounds the mestome bundles, separates the chlorenchyma from the exposed surface, and extends right along the ridges from one surface of the leaf to the other.

Chlorenchyma: Relatively small patches lining the ends of the furrows in horse-shoe form, and in bands lying at the sides of the ridges; cells small, irregularly polygonal, thin-walled.

Mestome bundles of typical monocotyledon structure, with parenchyma sheath, and mestome sheath with inner walls much thickened; one bundle in the middle of each ridge.

(*d.*) *Conclusion.*

The presence of the following characters shows that *Festuca littoralis* is strongly xerophytic: Tussock growth-form, leaf strongly involute, inner surface furrowed, with hairs, stomata in furrows, strong reduction of chlorenchyma and development of colourless thick-walled parenchyma, which may be considered a water-tissue.

Two points of difference from *Poa caespitosa* are interesting—namely, absence of stereome, which is compensated for by the thick walls of the colourless parenchyma; and thinner walls of chlorenchyma.

5. Scirpus nodosus.

(*a.*) *Habitat.*

Found in active dunes, commonly in manuka heath or sand-plain, also in sand-hollows, at both ends of the beach. Also occurs on coastal rocks and inland in heath river-bed, and occasionally steppe.

(*b.*) *Growth-form.*

Close, stiff, tussocks of rush-form, $1\frac{1}{2}$–3 ft. high, of numerous stems. Can be easily recognized by the inflorescence. Rhizome stout, woody.

Stems erect, stiff, slightly flattened, $\frac{1}{6}$–$\frac{1}{4}$ in. in diameter, dull green, functioning as leaves.

Roots long; root-hairs all along, rather long and sparse.

Leaves absent, except for reddish sheathing scales at the base of the stems.

Inflorescence characteristic; a head of spikelets towards the end of the stem, head brown, solitary, globose, $\frac{1}{3}$–$\frac{2}{3}$ in. in diameter, spikelets numerous, crowded together; head appears lateral, owing to the presence of a rigid bract, about 1 in. long, continuous with the stem.

(*c.*) *Anatomy.*

Stem a slightly flattened solid cylinder, consisting of epidermis, chlorenchyma, and stereome, fibro-vascular bundles, and central pith.

Epidermis: Cells above stereome bands rectangular, not much elongated, cell-walls thick, those parallel with stem-axis undulate; cells above chlorenchyma rather irregular; cell-walls not undulate; frequent stomata arranged parallel with axis, subsidiary cells present, thick cuticle; stomata slightly sunken.

Chlorenchyma in a continuous cylinder beneath the epidermis, interrupted on its outer side by bands of stereome; all palisade tissue, several cells deep, cells small and compact; a relatively large air-space beneath the stomata.

Stereome in thick bands, regularly arranged beneath the epidermis, all round the stem, forming ridges; stereome bands somewhat pear-shaped in transverse section; peculiar processes from the stereome, probably thickenings of cell-wall, are occasionally seen in the epidermis.

Fibro-vascular bundles: Structure typical of monocotyledons, with sheath of thick-walled cells and patch of thick-walled cells at the base of the bundle; bundles arranged in two or more rings, the outer ring of small bundles, the inner bundles larger and more well developed.

The centre of the stem consists of pith of large polygonal cells.

(*d.*) *Conclusion.*

Stem-structure is typically xerophytic, with thick cuticle, thick-walled epidermal cells, compact palisade, and stereome. The absence of leaves and the photosynthesizing stems are markedly xerophytic characters.

In connection with *Scirpus nodosus* a few words must be said about the tussock form. Cowles* says, "The leaves of most grasses and sedges grow so close together that the assumption of a position transverse to incident light is mechanically impossible. . . . Leaf verticality or parallelism to the incident light results obviously in minimum lighting for any individual

* "Text-book of Botany," vol. 2, Ecology, p. 544.

leaf, but there is maximum lighting for the vegetation as a whole, since the more vertical the leaves the more numerous may they be in any given space, and yet have sufficient light to live." And on page 666, on the subject of plants such as the rushes (*Juncus* and *Scirpus*), "It has been suggested that their exposure to intense light, reflected as well as direct, makes verticality almost as advantageous as in xerophytic habitats. It is much more likely that in rushes, as in swamp-grasses and in flags, verticality is advantageous because it permits a maximum display to light where growth is intense. Whatever may be the causes or advantages, it certainly is striking that leafless stems with a relative maximum of stem synthesis occur in such opposite habitats as deserts and swamps, and that the vertical habit which means minimum light-exposure and maximum protection for the desert individual means maximum light-exposure for the mass of vegetation in the swamp."

In the case of the various sand-dune species which exhibit the tussock form—*e.g.*, *Scirpus nodosus*, *Festuca littoralis*—it seems that because (1) the tussocks are commonly not closely packed together, and (2) the habitat is xerophytic, the advantage of the tussock form is one of protection against light-exposure and excessive transpiration. At the same time, with such a plant of *Leptocarpus simplex*, which grows in habitats varying from the dune to the swamp, it may be that the advantage of the tussock form and vertical leafless stem may be minimum light-exposure and maximum protection for the individual growing on dry sand, or maximum light-exposure for the mass of vegetation in the swamp.

6. Scirpus frondosus.

(*a.*) *Habitat.*

Scirpus frondosus is the most common of all plants on the sand-dunes at New Brighton. It covers both natural and artificial foredune, sharing its position on the artificial dune with the introduced marram-grass (*Ammophila arenaria*). Towards the Sumner end of the beach *Scirpus frondosus* reigns in almost undisputed sway on the foredune, the only other plant growing there being *Festuca littoralis*, with the introduced *Cakile maritima* on the shore close by. At the extreme end of the New Brighton beach, by the Sumner Estuary, opposite the Shag Rock, *Scirpus frondosus* is extremely common, giving to the dunes a very picturesque appearance by its orange-red colouring.

(*b.*) *Growth-form.*

A sedge, with leaves thickly arranged resembling tussocks, propagated enormously by means of its long thick rhizome; green, brownish, or orange in colour, giving a characteristic orange-brown colour to the vegetation.

Rhizome thick, stout, sometimes an inch in diameter, woody, fibrous (therefore hard to cut or break), long, creeping, often many yards in length covered with old brown leaf-sheaths; at frequent intervals giving rise to stems with tufts of numerous leaves.

Leaves numerous, closely packed, spreading, harsh, stiff, flexible, coriaceous, $1\frac{1}{2}$–2 ft. long, $\frac{1}{4}$–$\frac{1}{3}$ in. broad, narrowing to long trigonous points; upper surface concave, under convex; margins have small sharp teeth, and there are one or two rows of teeth on the convex under-surface. Young leaves green with orange or brown colouring towards the tips, bases yellow or yellowish-green, older leaves often orange or orange-red for the greater part of their length. Leaf at base broadens out into a sheath, brown, membranous, 3–4 in. long, about $1\frac{1}{2}$–2 in. broad at extreme base.

Inflorescence 4–9 in. long, clusters of spikelets spirally arranged around the upper part of the stem, each cluster subtended by a linear bract like the leaves, bracts about 2 ft. long, $\frac{1}{3}$ in. broad, expanding at base around the spikelets to about $\frac{1}{2}$–$\frac{3}{4}$ in. across. Spikelets densely crowded, brown or reddish-brown.

(*c.*) *Leaf-anatomy.*

Epidermis : Cell-walls thick ; some four or five rows of cells above each band of stereome, elongated, and with undulate cell-walls. About four rows of cells alternating with the stereome, cell-walls not so undulate, more irregular, and with stomata ; stomata sunken, arranged parallel with leaf-axis ; cuticle thick, orange-coloured commonly.

Chlorenchyma : A band extending from vascular bundles to epidermis, except where interrupted by stereome. Continuous except for the presence in the middle of the concave side of the leaf of large colourless polygonal cells just beneath the epidermis and continuous with the central parenchymatous tissue. Outer layers of chlorenchyma consist of palisade cells, compact. Towards the vascular bundles the chlorenchyma cells are more rounded or polygonal, with intercellular spaces, thus forming a tissue like spongy parenchyma ; air-spaces beneath stomata.

Stereome strongly developed—(1) subepidermal, in bands regularly arranged parallel to leaf-axis, and alternating with groups of palisade cells ; (2) with vascular bundles. In adult plant, stereome forms thick cords in the central colourless parenchyma, adjacent to the bundles ; also a well-developed sheath around each bundle. In the portion of this sheath nearest the chlorenchyma plainly appear passage-strands, radiating from the central cavity of the cells. As in *Scirpus nodosus*, peculiar processes appear from the stereome into the epidermis.

Fibro-vascular bundles are arranged in one or two rings just internal to the chlorenchyma, with thick-walled sheaths enclosed in colourless parenchyma sheath. The stereome groups are developed adjacent to the vascular bundles towards the convex surface, not to those on the concave.

The chief points in which the adult plant differs from the seedling are the development of stereome tissue, and the increased compactness of the chlorenchyma.

(*d.*) *Conclusion.*

Scirpus frondosus, with its characteristics—tufted growth-form, rigid arched leaf, thick cuticle, sunken stomata, compact chlorenchyma cells, and strong development of stereome—is a typical xerophyte. Also, the well-developed rhizomes, with their ability to strike upwards and root, save the plant from being buried by wind-blown sand, and give to it its strong sand-binding propensity. Thus *Scirpus frondosus* is, by both habit and structure, well adapted to its environment.

7. Carex pumila.

(*a.*) *Habitat.*

Found in moist sand hollows or plains commonly in northern portion of the New Brighton beach. The plant acts as a minor sand-binder when a hollow is invaded by sand.

(*b.*) *Growth-form.*

A small sedge, 1 ft. or less in height, with leaves arching over towards the ground.

Rhizome long, creeping, giving rise at intervals to new plants.

Leaves sheathing at the base, sheaths completely surrounding the stem; about $\frac{1}{8}$ in. broad, grooved, glaucous-green, coriaceous, upper surface concave, leaf bending over towards the ground and tapering to a point, midrib prominent in adult leaf.

(*c.*) *Leaf-anatomy.*

Epidermis: On concave surface epidermis consists of large bulliform cells; in the seedling the cells in the middle of this surface extend fully a quarter of the way into the leaf. Convex surface—oblong cells with thick cell-walls, those parallel to the leaf-axis being undulate; stomata frequent, parallel to leaf-axis; level with surface; cuticle present.

Chlorencyhma: In the seedling, slightly differentiated, with palisade cells towards the outside and polygonal cells in the interior; water-storage tissue in the chlorenchyma cells, beginning to appear between mestome bundles. In the adult there are two or three layers of palisade cells on the surface, about two on the concave surface; inner cells irregular, polygonal, with intercellular spaces. Large water-storage tracts alternate with the bundles, sometimes there being only one layer of chlorenchyma around the parenchyma sheath.

Stereome occurs adjacent to the vascular bundles or subepidermal in origin.

Fibro-vascular bundles in a single row through the leaf, surrounded by a mestome sheath and a parenchymatous sheath, some cells containing chloroplasts, others quite colourless.

(*d.*) *Conclusion.*

Carex pumila, as far as anatomy goes, is xerophytic; for instance, cuticle, chlorenchyma differentiated with palisade tissue on both sides of leaf, well-developed water-storage tissue, large epidermal cells on the concave surface which can contract when dry and thus enable the leaf to protect itself against transpiration by arching. The tufted growth-form is also xerophytic. All this is contrary to what might be expected from the fact that the plant grows in moist hollows.

8. **Leptocarpus simplex.**

(*a.*) *Habitat.*

Found commonly in moist hollows, sand-plains, and marshy places. At the south end of the beach it grows chiefly on the sand-plain among the manuka (*Leptospermum scoparium*), and in the north portion it is common in wet places and in pools. Besides growing in dune areas, it is the most characteristic plant of salt swamp; but it also occurs under mesophytic conditions inland, as on the gravel shores of Lakes Te Anau and Manapouri.

(*b.*) *Growth-form.*

A rush-like plant which forms dense tussocks of a dull-green or brownish-yellow colour, to which a characteristic mottled appearance is given by the numerous small blackish scales clasping the stem at intervals of about 3 in.

Rhizome stout, woody, creeping, covered with brown scales.

Stems erect, stiff, wiry, terete, rush-like, slender, diameter less than $\frac{1}{16}$ in; 1–3 ft. long.

Leaves reduced to scales.

(*c.*) *Anatomy.*

Stem a solid cylinder, consisting of epidermis, chlorenchyma and stereome, fibro-vascular bundles, and pith.

Epidermis : Cuticle very thick ; stomata numerous, above the bands of chlorenchyma, sunken, subsidiary cells present.

Chlorenchyma : A ring of bands alternating with stereome ; about two to three layers of palisade cells, bands about six cells wide.

Stereome well developed ; thin bands between chlorenchyma bands, joining into a thick cylinder internal to the chlorenchyma.

Fibro-vascular bundles occur in three rings. The outer ring consists of very small bundles in the inner ends of the narrow stereome bands between the groups of chlorenchyma. The second ring is embedded in the stereome cylinder, and the third ring of larger vascular bundles in the pith, with patches of stereome adjoining the bundles and connected with the stereome cylinder. In transverse sections stained with haematoxylin and saffranin, the phloem and smaller xylem elements are apparent, but the larger xylem vessels appear the same as the surrounding pith.

Pericycle apparent, consisting of a discontinuous ring of cells between the chlorenchyma and the stereome cylinder, and interrupted at the stereome bands. Internal to the stereome is a cylinder of thick-walled polygonal cells, separated by a ring of cells resembling stereome from an inner mass of large thin-walled polygonal cells in the centre of the stem.

(*d.*) *Conclusion.*

Leptocarpus simplex shows the following xerophytic characters : Tussock form (this has already been discussed in connection with *Scirpus nodosus*), reduction of leaves, and stems taking on the function of photosynthesis ; very thick cuticle, sunken stomata ; compact palisade cells, stereome strongly developed.

The plant, therefore, seems fitted for any xerophytic position, and yet, on the dunes, it grows in moist hollows. Its xerophytic characters are therefore much more in harmony with its halophytic habitat than with its position in the sand-hollow.

9. Pimelea arenaria.

(*a.*) *Habitat.*

Only two shrubs of *Pimelea arenaria* were found, though it is common in New Zealand dune areas generally ; these were at the extreme south end of the beach, near the Sumner Estuary. They grew on the active dune, in exposed position, among *Scirpus frondosus.*

(*b.*) *Growth-form.*

A leafy, much-branched, spreading, and rather procumbent shrub. The lower part of the stem is low-growing, the upper part erect and thickly leaved, with corymbose branching. Leaves at top of branches closely pressed together, overlapping one another, with under-surface outwards, covered with shiny white hairs.

Stems woody, flexible, dark brown, lower part leafless, upper twigs leafy for about 4 in. from top, tufts of hairs in axils of branches, and upper twigs hairy.

Leaves opposite, decussate, sessile or with short knob-like petioles closely appressed to the stem; each pair of leaves about $\frac{1}{4}$–$\frac{3}{8}$ in. apart; leaves standing out from the stem at an angle of 30° usually, but varying to 80°; $\frac{1}{3}$–$\frac{3}{8}$ in. long, $\frac{1}{4}$–$\frac{1}{3}$ in. broad; some lower leaves bend downwards at the tip, many are flat, others slightly hollow on upper surface; ovate in shape, varying from elliptic-oblong to almost orbicular, ending in a blunt point; thick, coriaceous, only a mid-vein apparent, upper surface smooth or with few hairs, under-surface thickly covered with silky white appressed hairs.

Flowers in heads at the top of the branches, at the very tip or in the axil of a topmost branch. Flowers sessile, white; perianth cylindrical with spreading limbs, covered with silky hairs; four perianth leaves; stamens two, seated upon the perianth, opposite the two outer lobes; ovary superior; one carpel, one ovule; stigma capitate, style brownish-red. Fruit a berry, white, fleshy.

(*c.*) *Leaf-anatomy.*

Epidermis: Dorsal surface—cells irregular, thick-walled; stomata frequent, irregularly disposed, sunken; thick cuticle. Beneath the upper epidermis is a layer of very large colourless cells, probably for water-storage. Ventral surface—cell-walls thick, cells somewhat polygonal in shape, stomata numerous, clefts pointing in all directions, sunken cuticle present; numerous long hairs, unicellular, thick-walled, secreting rather sticky fluid.

Chlorenchyma only slightly differentiated; cells rounded, upper layers not definitely palisadic, rather loosely arranged; lower cells loose, forming sort of spongy mesophyll; air-spaces on both surfaces beneath stomata. Patches of water-storage cells alternating with vascular bundles.

(*d.*) *Conclusion.*

Pimelea arenaria is always a plant of semi-stable dunes, and its growth-form, with small leaves growing close together, and the whole plant procumbent and close-growing, is typically xerophytic. The leaf is xerophytic in certain anatomical characters—*e.g.*, in having thick cuticle, thick-walled epidermis, sunken stomata, water-storage cells, under-surface protected by hairs—yet mesophytic in other respects, especially in the important point of chlorenchyma structure.

10. Leptospermum scoparium.

(*a.*) *Habitat.*

Very common on stable dune, and especially upon heath plains; it forms close brown patches of varying size, interspersed among *Cassinia fulvida*, *Discaria toumatou*, *Carmichaelia subulata*, *Leptocarpus simplex*, and *Scirpus nodosus*. On the fixed plains towards the southern end of the beach the manuka is rather more stunted in height, and forms large patches, sometimes near patches of the bracken fern (*Pteridium esculentum*). At the northern end the manuka is commonly found in the vicinity of standing water. Besides occurring on dunes, *L. scoparium* is the dominant heath plant of New Zealand. It occurs also in swamps, bogs, and on rocks.

(*b.*) *Growth-form.*

A stunted or erect brownish shrub, varying in size and shape, with spreading, leafy branches; from $1\frac{1}{2}$ ft. to 3 ft. high, sometimes forming considerable colonies.

Stems woody, brown, much branched.

Leaves about $\frac{1}{4}$ in. long, $\frac{1}{10}$–$\frac{1}{6}$ in. broad, varying in shape, lanceolate or ovate, ending in a sharp point, sessile, rigid, thick, underside convex with midrib apparent, otherwise leaf apparently veinless; dotted, usually spreading; brown in colour.

Flowers: Solitary, sessile, in axil of group of leaves or at end of branch; usually $\frac{1}{3}$–$\frac{1}{2}$ in. diameter. Calyx-tube brown, top-shaped, ending in five small brownish-white membranous lobes. Petals white, spreading, with a small claw, almost orbicular, $\frac{1}{6}$ in. or more in diameter, with brownish veins. Stamens numerous in a ring around the top of the perianth-tube. Ovary semi-inferior, usually with five carpels, multilocular, with numerous linear slightly curved seeds in each loculus. Stigma capitate, almost peltate. Fruit a capsule, brown, woody, persistent, with persistent calyx-tube forming a rim around it.

(*c.*) *Leaf-anatomy.*

Epidermis: Cells thick-walled, rounded, square, rectangular or polygonal in shape (surface view); above the glands there are two long cells surrounded by a ring of smaller cells. Cuticle thick on both surfaces. Upper surface, no stomata; on under-surface stomata numerous, irregularly arranged, prominent as regards epidermis, but sunk beneath the cuticle.

Chlorenchyma differentiated; two or more layers of palisade cells on upper surface, spongy mesophyll in the middle, and palisade cells on the underside; cells loosely arranged, with intercellular spaces, and air-spaces adjacent to stomata. Large glands containing aromatic oil, embedded in the chlorenchyma just beneath the epidermis on both sides of the leaf. Stereome in two patches, above and below each vascular bundle.

Fibro-vascular bundles: About three seen in transverse section in the chlorenchyma with stereome, and parenchyma sheath. In transverse section of the woody stem, the large polygonal pith cells in the centre contained round starch grains, some of the cells staining deeply, others scarcely at all.

(*d.*) *Conclusion.*

Leptospermum scoparium exhibits the following xerophytic characters: Small stiff leaves, relatively thick, thick cuticle on both surfaces, thick-walled epidermis, stomata only on under-surface, palisade tissue on both sides of the leaf, stereome developed in vascular bundles. With regard to its growth-form the following quotation from Cockayne* is instructive: "*Leptospermum scoparium* Forst. (Myrtac.) may be a moderate-sized tree, a tall shrub, a dwarf plant 2–8 cm. tall which flowers and ripens seed, and *an absolutely prostrate plant* which forms a dense covering to the ground and puts forth adventitious roots, although the erect forms are exceeding difficult to artificially strike as cuttings." Its varied habitats are for the most part xerophytic, so that its leaf-anatomy, considered along with the variety of growth-forms, may in general be considered epharmonic.

11. **Epilobium Billardierianum.**

(*a.*) *Habitat.*

Found in moist sand-hollows.

(*b.*) *Growth-form.* Figs. 1 to 3.

A small herb with the lower part of the stem rather woody and low-growing, from which arise several stolons running along the ground and

* Trans. N.Z. Inst., vol. 44, p. 14.

giving off rather long adventitious roots and leaves at short intervals. Stem reddish in parts, with tiny white hairs.

Leaves glabrous, bright green, sessile, $\frac{3}{4}$–1 in. long, in shape usually oblong-ovate or linear-oblong, tips obtuse usually, margins denticulate, pinnately veined, midrib prominent, leaves on erect stems decussate.

Fruit a capsule, about 2 in. long, $\frac{1}{12}$–$\frac{1}{10}$ in. wide; four carpels, each carpel forming a rounded ridge; numerous seeds, small and brown, surmounted by tuft of white silky hairs.

(*c.*) *Leaf-anatomy.*

Epidermis: On both surfaces walls thin, wavy, no cuticle; stomata frequent, prominent.

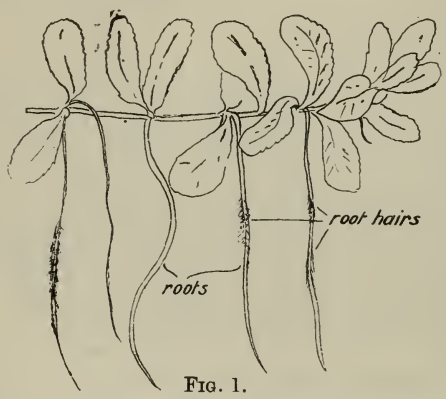

Fig. 1.

Fig. 2.

Fig. 1.—*Epilobium Billardierianum:* Growth-form with creeping stem.
Fig. 2.—*Epilobium Billardierianum:* Erect stem with decussate leaves.

Chlorenchyma differentiated; on upper surface large rounded cells, elongated like palisade cells; towards lower surface spongy mesophyll with large intercellular spaces; chloroplasts large and round; crystals (raphides) found commonly in the mesophyll.

Fibro-vascular bundles: Large vein in midrib surrounded by mass of colourless parenchyma; a few smaller bundles appear in transverse section in the mesophyll.

(*d.*) *Conclusion.*

This plant is evidently a strong mesophyte, from the following characters: Leaf delicate and green, no cuticle, prominent stomata, epidermal cell walls thin, structure of chlorenchyma, large intercellular spaces.

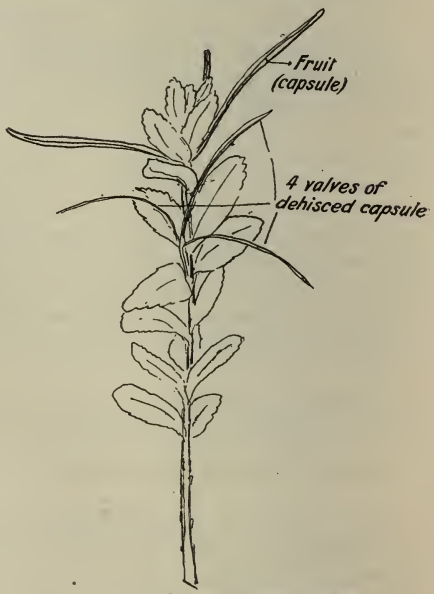

Fig. 3.—*Epilobium Billardierianum:* Flowering stem.

This plant grew well when pot-grown in the greenhouse, seeming to endure both moisture and dryness. Some shoots grew erect, others bent over the sides of the pot and took root in the sand beneath.

12. Epilobium nerterioides.

(*a.*) *Habitat.*

Very common in moist sand-hollows at both ends of the beach. On the south end it grew commonly with *Selliera radicans*, forming sparse carpets on the surface of the sand.

(*b.*) *Growth-form.*

A small creeping herb, with stem covered, and only the leaves visible above the sand in its natural habitat, forming a double row or small patch of leaves dotted more or less closely over the sand.

Stem long, creeping, often under sand, herbaceous, slender, giving rise at intervals of about $\frac{1}{6}$–$\frac{1}{3}$ in. to a pair of leaves and a rootlet or two.

Leaves opposite, with short petioles, $\frac{1}{8}$–$\frac{1}{4}$ in. long, the blade orbicular or orbicular-ovate, apex rounded, top bent slightly downwards, margins entire, green, glabrous, slightly fleshy.

Capsule four-lobed, about $\frac{3}{4}$ in. long, on peduncle longer than the capsule.

(*c.*) *Leaf-anatomy.*

Epidermis : On both surfaces walls thin, wavy outline ; stomata numerous, irregularly arranged, prominent ; a few unicellular hairs occur, with granular contents ; no cuticle.

Chlorenchyma : On upper surface very large palisade cells ; on underside spongy mesophyll, with large intercellular spaces. In section parallel to surface chlorenchyma cells are circular, with large chlorophyll grains arranged round the walls ; crystals (raphides) commonly found embedded in cells in the mesophyll.

Fibro-vascular bundles few and small, consisting of a few xylem vessels, spiral chiefly, and a small patch of phloem ; bundles surrounded by a parenchyma sheath.

(*d.*) *Conclusion.*

Leaf-anatomy shows that this plant, like *Epilobium Billardierianum*, is a strong mesophyte, although its prostrate habit appears xerophytic. The plant is very variable in habit; when grown in ordinary dry sand in the greenhouse many shoots grew erect, and the leaves were longer and narrower and of a darker green. Sections taken of these leaves which grew up into the light showed that the cells are smaller and more numerous.

13. Gunnera arenaria.

(*a.*) *Habitat.*

Common in damp sand-hollows, towards north end of New Brighton beach ; not found at south end.

(*b.*) *Growth-form.*

A small plant forming leafy patches or round mats often several feet in diameter. Conspicuous when in fruit.

Rhizome stout, with withered leaf-bases.

Leaves dull green, fleshy, with fleshy petioles; leaf 1–2 in. long, including the petioles, which are longer than the blade; $\frac{1}{3}$–$\frac{5}{12}$ in. broad; petioles sheathing at the base, and hairy; leaves broadly ovate, margins crenate; large veins prominent on under-surface.

Fruit conspicuous. Peduncles elongated, often 3 in. long or more, projecting above the foliage, with raceme of fleshy orange-coloured drupes, pendulous, $\frac{1}{6}$–$\frac{1}{4}$ in. long.

(*c.*) *Anatomy.* Fig. 4.

Epidermis: On both surfaces cells large, walls thin, outline wavy in surface view, no cuticle; stomata frequent, prominent, wide open, guard-cells containing numerous chloroplasts.

Chlorenchyma differentiated; on upper side two layers of palisade cells, the rest of the chlorenchyma consisting of large rounded cells; air-spaces beneath stomata. Embedded in the chlorenchyma were seen large round cells containing sphaerocrystals.

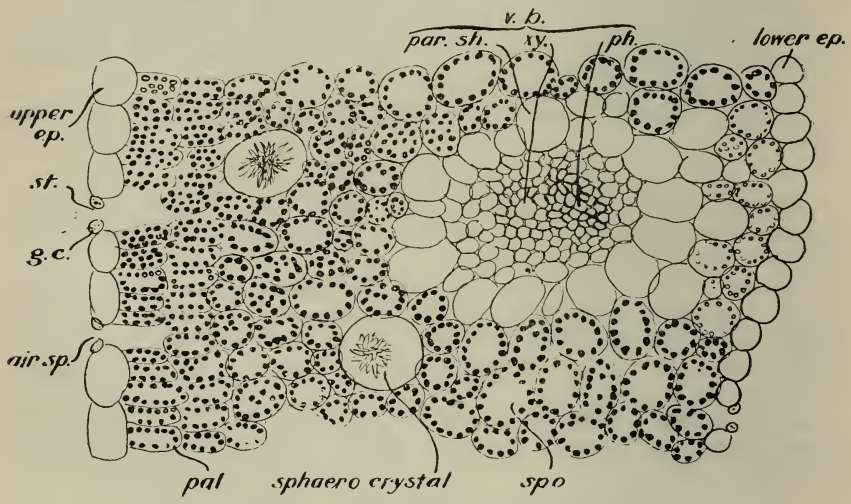

Fig. 4.—*Gunnera arenaria:* Part of T.S. of leaf.

Fibro-vascular bundles: Small patch of phloem towards underside, beneath a patch of xylem; bundle surrounded by sheath of large round colourless cells.

When the stem is cut through, two or three blackish specks on the cut ends can be seen by the naked eye. On microscopical examination these are seen to be caused by the presence in the outer cortex of colonies of *Nostoc.*

(*d.*) *Conclusion.*

The habit and the fleshy reduced stem of *Gunnera arenaria* are xerophytic; but the leaf, with its prominent wide-open stomata on both surfaces, large rounded chlorenchyma cells, large chloroplasts, and well-marked sponge parenchyma, is strongly mesophytic, in accordance with the moist habitat.

This plant, pot-grown in the greenhouse, throve both when watered regularly and when kept dry.

14. **Crantzia lineata.**

(*a.*) *Habitat.*

Found in damp places towards north end of New Brighton beach, often carpeting the ground in company with *Selliera radicans* and *Epilobium.* Also found elsewhere on rock, in salt meadow, and in shallow water.

(*b.*) *Growth-form.*

A small plant forming mats of narrow erect green rush-like leaves.

Rhizome slender, creeping.

Leaves arising in tufts along the rhizome, narrow, linear, 1–3 in. long, hollow, cylindrical, slightly compressed, apex blunt, leaves appear jointed by reason of dark ring-like markings across the leaf at intervals of about $\frac{1}{5}$–$\frac{1}{4}$ in.

Inflorescence a simple umbel with about four pedicels $\frac{1}{4}$–$\frac{1}{2}$ in. long, surmounted by ovoid or oblong-globose fruit, with ridges and furrows; tiny bracts at base of umbel.

(*c.*) *Anatomy.* Fig. 5.

Epidermis : Cells irregular, elongated in direction of axis, walls thin, transverse walls often oblique; stomata prominent, not very frequent clefts usually parallel with axis; no cuticle.

Chlorenchyma : Large round cells, the outer layer slightly compressed like palisade cells, the inner cells circular in transverse section, longer than broad in section parallel to axis; chlorophyll grains large, round, numerous; air-spaces beneath stomata.

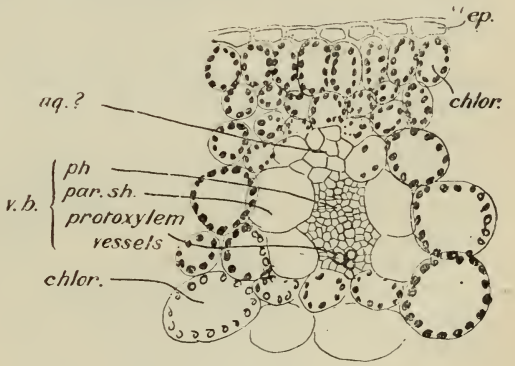

FIG. 5.—*Crantzia lineata :* Part of T.S. of leaf, showing vascular bundle.

Fibro-vascular bundles : About three in each leaf, consisting of a mass of phloem towards the outside and a very few xylem vessels. Bundle surrounded by a colourless sheath of parenchyma, with a few smaller polygonal cells above the phloem, perhaps for water-storage.

(*d.*) *Conclusion.*

The so-called "leaves" of *Crantzia lineata* are probably phyllodes. The rush form and leaf-reduction are xerophytic characters, but anatomy reveals mesophytic characters—*e.g.* prominent stomata, large rounded chlorenchyma cells with large chlorophyll grains, well-developed spongy tissue, and rudimentary vascular system.

This plant was grown in the greenhouse, and grew well when kept moist and when dry.

15. **Calystegia Soldanella.**

(*a.*) *Habitat.*

Common on active dunes, where, owing to its prostrate habit and long rhizomes, it binds together and renders stable the mounds of sand on which it grows.

(*b.*) *Growth-form.*

A prostrate creeping herb forming mats over the sand, with showy convolvulus flowers.

Rhizome long, creeping.

Stems prostrate, trailing, of varying thickness, cord-like, much branching.

Leaves many, on petioles 1–3 in. long, blade in breadth reaching 2 in., broader than long, reniform, basal sinus broad and shallow ; leaves green, fleshy.

Corolla showy, pale lilac in colour.

Seeds blackish-brown, numerous.

(*c.*) *Leaf-anatomy.*

Epidermis much the same on both surfaces, formed of large polygonal cells ; stomata numerous, clefts in all directions, on a level with surface, and placed within two cells similar to the guard-cells (these are the " biceller " referred to by Warming, " Halofyt-Studier," p. 33, under *Convolvulus Soldanella*, and p. 21 under *Ipomoea pes caprae*). On epidermis of both surfaces are glandular hairs, consisting of a ring of wedge-shaped cells. These glandular hairs are the " kirtelhaar " described by Warming. In the epidermal cells around them the cuticle is thicker than elsewhere, and the surface is wrinkled.

Chlorenchyma differentiated ; about four upper layers of the palisadic type, rather loosely arranged. On the underside the cells are rounded and more loosely arranged, with large intercellular spaces ; air-spaces beneath stomata.

Ramifying through the chlorenchyma are lacteal veins (the " maelkerorene " of Warming), usually near the vascular bundles. These ducts are surrounded with a layer of cells tangentially stretched, and their contents appear granular.

Fibro-vascular bundles numerous. The mid-vein is surrounded by a ring of five or six " maelkerorene," embedded in colourless parenchyma. Each vascular bundle consists of a mass of xylem and of phloem, with parenchyma, surrounded by a parenchyma sheath.

(*d.*) *Conclusion.*

The characters of the leaf are in part xerophytic—*e.g.*, cuticle, lacteal veins, and water tissue near the veins ; but, on the whole, the leaf is mesophytic, with its unprotected stomata on both sides of the leaf, and the structure of the chlorenchyma. It is therefore the habit of the plant rather than its structure which fits it for its position.

16. Coprosma acerosa.

(*a.*) *Habitat.*

Found fairly frequently, in rounded masses, on the active dunes at both ends of New Brighton beach ; often in company with *Cassinia fulvida*.

(*b.*) *Growth-form.*

A spreading, ragged, low-growing, matted shrub, with woody interlacing stems and clusters of small linear leaves. Forms wiry cushions or mats about 2 ft. high and several feet in diameter.

Stems flexible, and covered with brown bark ; curving in all directions; branches at various angles, often at right angles.

Leaves often appear whorled, arising in opposite pairs, or clusters of two to four leaves, sometimes on small branches; dull green, linear, relatively thick, obtuse or subacute, $\frac{1}{4}$–$\frac{1}{2}$ in. long, $\frac{1}{20}$–$\frac{1}{16}$ in. wide, mid-vein apparent. Fruit a white fleshy drupe, about $\frac{1}{4}$ in. long.

(*c.*) *Leaf-anatomy.* Fig. 6.

Epidermis of polygonal cells with rather thick walls and outline slightly waved, cells seeming granular and to contain chloroplasts; stomata very frequent, enclosed in two epidermal cells, and rather prominent; a thin cuticle. Epidermis much the same on both surfaces.

Chlorenchyma: Layers of palisadic cells on both surfaces, rather loosely arranged, cells towards the middle much looser, with large intercellular

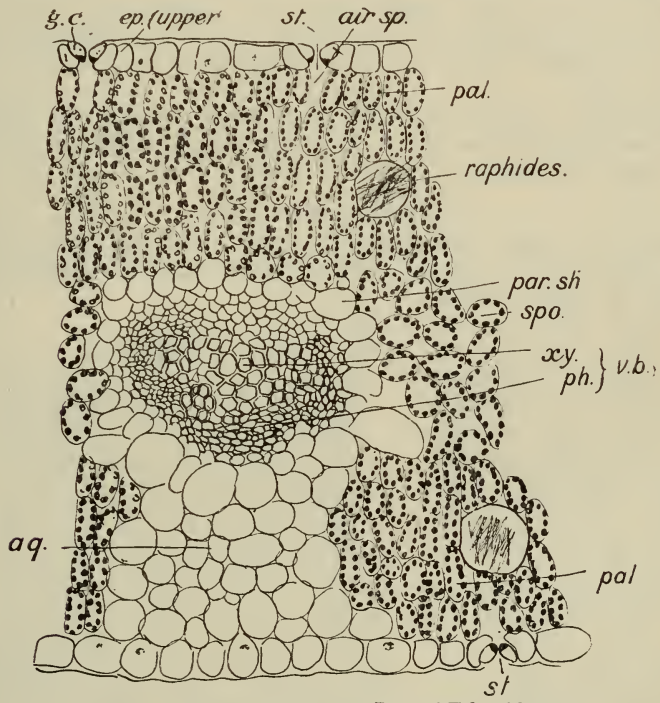

FIG. 6.—*Coprosma acerosa:* Part of T.S. of leaf.

spaces. Embedded in the chlorenchyma are several cells containing small raphides (found, when tested, to be crystals of calcium oxalate).

Fibro-vascular bundles: Five or six seen in transverse section, traversing the mesophyll; a mass of colourless parenchyma cells, probably for water-storage, adjacent to the mid-vein, on the ventral surface; bundles well developed, a mass of xylem and a considerable amount of phloem; each bundle surrounded by a parenchyma sheath.

(*d.*) *Conclusion.*

The almost isolateral leaf, strong development of palisade tissue, and presence of water tissue are xerophytic characters; otherwise the leaf is mesophytic. Here, again, as in *Calystegia Soldanella* and *Pimelea arenaria*, it seems that the habit of the plant rather than its structure fits it for its exposed position on the active dune.

17. Cassinia fulvida.

(*a.*) *Habitat.*

Common on active dunes on both ends of New Brighton beach, where it is a characteristic heath plant.

(*b.*) *Growth-form.*

A heath-like, much-branched shrub, 3–4 ft. high, often straggling, of a characteristic tawny-yellow colour.

Stems at first sparingly branched, but much branched towards the top. Upper branches flexible, and covered with a golden-yellow tomentum of thickly matted hairs, giving rise at close intervals to shorter tomentose branches 2–3 in. long, almost erect, these branches being thickly clothed with leaves.

Leaves small, thick, green above, but under-surface covered with tomentum, midrib prominent and yellowish; small orange close-set petioles, making leaf appear sessile; $\frac{1}{6}$–$\frac{1}{3}$ in. long, oblong or linear-obovate, obtuse, alternate, entire.

Inflorescence: Numerous small white heads arranged in corymbs at the end of leafy branches. The plant often bears whitish leaf-like galls, which appear like inflorescences from a distance.

(*c.*) *Leaf-anatomy.* Fig. 7.

Epidermis: Upper surface covered with thick yellow waxy covering; cuticle rather thick, epidermal cells polygonal, with thick walls, a sparse covering of hairs running through the wax; no stomata. Under-surface: stomata numerous, prominent, arranged in all directions, guard-cells with numerous chloroplasts; epidermal cells irregular, no cuticle, a dense covering of thickly matted unicellular hairs that seem to exude oily drops.

Chlorenchyma differentiated. About four layers of fairly compact palisade cells on upper side, loose round cells forming a spongy mesophyll on lower side; air-spaces above stomata.

Fibro-vascular bundles: About five seen in transverse section; each consists of a mass of xylem above an equal mass of phloem, and is surrounded by a parenchyma sheath.

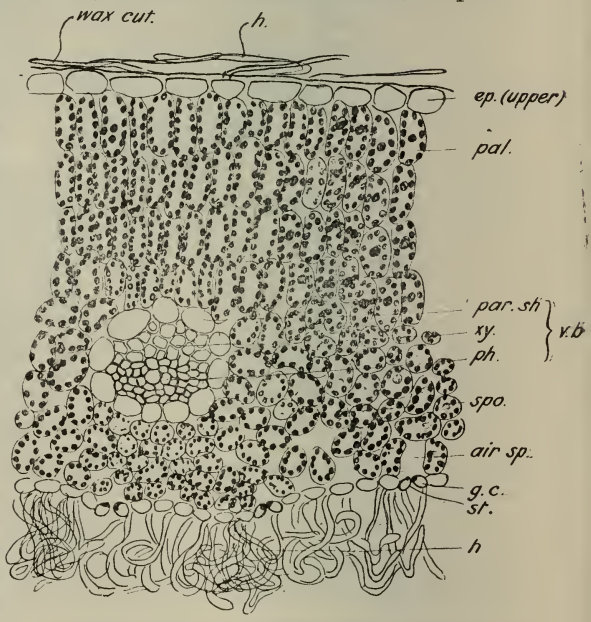

Fig. 7.—*Cassinia fulvida:* Part of T.S. of leaf.

(*d.*) *Conclusion.*

Leaf-anatomy reveals strong xerophytic characters—wax covering and cuticle on upper surface, dense hairs on under, thick-walled epidermal cells, stomata only on ventral surface, palisade tissue of several compact layers. The plant is therefore well fitted for its exposed position by the xerophytic character of both habit and structure.

E. TABLE OF LEAF-CHARACTERS, EXTERNAL AND ANATOMICAL.

—	Growth-form.			Leaf, Outward Appearance.							
	Tussock or Tufted.	Stems reduced or creeping.	Close-growing Shrubs.	Absent or Scaly.	Small.	Grass-like, Reed-like, or Linear.	Conduplicate or Involute.	Concave or Arched.	Bifacial.	Apparently Mesophyte.	Cylindrical.
1. *Calamagrostis Billardieri* ..	x	..	..	..	..	x	..	..	x	..	..
2. *Arundo conspicua* ..	x	..	..	..	..	x	x	..	x	..	..
3. *Poa caespitosa*	x	..	..	..	..	x	x	..	x	..	..
4. *Festuca littoralis* ..	x	..	..	..	..	x	x	..	x	..	..
5. *Scirpus nodosus* ..	x	..	..	x	..	..	..	..	..	..	..
6. —— *frondosus*	x	..	..	..	..	x	..	x	x	..	..
7. *Carex pumila*	x	..	..	..	..	x	..	x	x	..	..
8. *Leptocarpus simplex* ..	x	..	..	x	..	..	..	..	..	..	..
9. *Pimelea arenaria* ..	..	..	x	..	x	..	..	..	x	x	..
10. *Leptospermum scoparium*	..	..	x	..	x	..	..	..	x	..	..
11. *Epilobium Billardierianum*	..	..	..	..	..	..	..	..	x	x	..
12. —— *nerterioides* ..	..	x	..	..	x	..	..	..	x	x	..
13. *Gunnera arenaria* ..	x	x	..	..	..	..	..	..	x	..	..
14. *Crantzia lineata* ..	x	..	..	?	..	x	..	..	..	x	x
15. *Calystegia Soldanella* ..	..	x	..	..	..	..	..	..	x	x	..
16. *Coprosma acerosa* ..	..	..	x	..	x	..	..	..	..	..	..
17. *Cassinia fulvida* ..	..	..	x	..	x	..	..	..	x	..	..

—	Epidermis.										Large Epidermal Cells in T.S.
	Cuticle.					Cell-walls.					
						Exposed Surface.		Protected Surface.			
	Present.	Thick.	Wax Covering.	Teeth.	Hairs.	Thick.	Undulate.	Thick.	Undulate.	Wavy Outline.	
1. *Calamagrostis Billardieri* ..	x	..	..	..	..	x	..	x	..	..	x
2. *Arundo conspicua* ..	x	x	..	x	x	x	x	..	..	..	..
3. *Poa caespitosa*	x	x	..	..	x	x	x	..	..	..	..
4. *Festuca littoralis* ..	x	x	..	..	x	x	x	..	..	..	..
5. *Scirpus nodosus* ..	x	x	..	..	..	x	x	..	..	..	..
6. —— *frondosus* ..	x	x	..	x	..	x	x	..	..	..	x
7. *Carex pumila*	x	..	..	..	..	x	x	x	x	..	x
8. *Leptocarpus simplex* ..	x	x	..	..	..	x	..	..	..	..	..
9. *Pimelea arenaria* ..	x	x	..	..	x	x	..	x	..	..	..
10. *Leptospermum scoparium*	x	x	..	..	..	..	..	x	..	..	..
11. *Epilobium Billardierianum*	..	..	..	..	..	..	..	..	..	x	..
12. —— *nerterioides* ..	..	..	..	..	x	..	..	..	..	x	..
13. *Gunnera arenaria* ..	..	..	..	..	..	..	..	..	..	*	..
14. *Crantzia lineata* ..	..	..	..	..	..	..	..	..	..	..	..
15. *Calystegia Soldanella* ..	x	..	..	..	x	..	..	..	..	..	..
16. *Coprosma acerosa* ..	x	..	..	..	..	x	..	x	..	..	..
17. *Cassinia fulvida* ..	x	..	x	..	x	x	..	x	..	..	..

* Slightly.

—	Stomata.									Hairs.					
	On Both Surfaces.	On One Surface only.	Prominent.	Level with Surface.	Sunken.	In Furrows.	Parallel to Leaf-axis.	Irregularly disposed.	Subsidiary Cells present.	On Both Surfaces.	On One Surface only.	Dense Covering.	Unicellular or Simple.	Pluricellular.	Glandular.
1. *Calamagrostis Billardieri*	x	..	..	..	x	x	x	..	x	..	..	..	..	..	..
2. *Arundo conspicua* ..	..	x	..	..	..	x	..	..	x	..	..	..	..	..	..
3. *Poa caespitosa* ..	..	x	..	..	x	..	x	..	x	..	x	..	x	..	..
4. *Festuca littoralis* ..	..	x	..	x	..	x	x	..	x	..	x	..	x	..	..
5. *Scirpus nodosus* ..	..	..	..	..	*	..	x	..	x	..	..	..	..	..	..
6. —— *frondosus* ..	x	..	..	..	x	..	x	..	x	..	..	..	..	..	..
7. *Carex pumila* ..	..	x	..	x	..	..	x	..	x	..	..	..	..	..	..
8. *Leptocarpus simplex*	..	..	..	..	x	..	x	..	x	..	..	..	..	..	..
9. *Pimelea arenaria* ..	x	..	..	..	x	..	..	x	..	..	x	x	x	..	..
10. *Leptospermum scoparium*	..	x	..	..	*	..	..	x	..	..	..	..	..	..	†
11. *Epilobium Billardierianum*	x	..	x	..	..	..	..	x	..	..	..	..	..	..	..
12. —— *nerterioides* ..	x	..	x	..	..	..	..	x	..	x	..	..	x	..	..
13. *Gunnera arenaria* ..	x	..	x	..	..	..	..	x	..	..	..	..	..	..	..
14. *Crantzia lineata* ..	..	..	x	..	..	..	x	..	..	..	..	..	..	..	..
15. *Calystegia Soldanella*	x	..	..	x	x‡	..	..	x	x	x	..	..	..	x	x
16. *Coprosma acerosa* ..	x	..	..	x	..	..	..	x	x	..	..	..	..	..	..
17. *Cassinia fulvida* ..	..	x	x	x	..	..	..	x	..	x	x	x	x	..	..

* Slightly. † Glands. ‡ Or slightly.

—	Chlorenchyma.															
			Palisade.													
	Homogeneous.	Differentiated.	Two or more Layers.	On Two Sides of Leaf.	Compact.	Large Cells.	Well-marked Sponge Tissue.	Intercellular Spaces present.	Polygonal Compact Cells with no Space.	Cells large.	Polygonal.	Cells rounded.	Chloroplasts large.	Cell-walls thick.	Water Tissue present.	Crystals found.
1. *Calamagrostis Billardieri*	x	..	..	..	..	..	..	x	..	..	x	..	..	..	..	..
2 *Arundo conspicua* ..	x	..	..	..	..	..	..	x	..	..	x	..	..	..	x	..
3 *Poa caespitosa* ..	x	..	..	..	..	..	..	..	x	..	x	..	..	x	..	..
4. *Festuca littoralis* ..	x	..	..	..	..	..	..	x	..	..	x	..	..	..	x	..
5. *Scirpus nodosus* ..	x	..	x	..	x	..	..	x	..	..	..	..	..	..	..	..
6. —— *frondosus* ..	..	x	x	..	x	..	..	x	..	..	..	..	..	..	?	..
7. *Carex pumila* ..	..	x	..	x	..	..	..	x	..	..	..	..	..	..	x	..
8. *Leptocarpus simplex*	x	..	x	..	x	..	..	..	..	..	..	..	..	..	..	x
9. *Pimelea arenaria* ..	..	x	..	..	..	..	x	x	..	..	..	x	..	..	x	..
10. *Leptospermum scoparium*	..	x	x	x	..	..	x	x	..	..	..	..	..	..	..	..
11. *Epilobium Billardierianum*	..	x	x	..	..	x	x	x	..	x	..	x	x	..	x	x raphides
12. —— *nerterioides* ..	..	x	x	..	..	x	x	x	..	x	..	x	x	..	..	x raphides
13. *Gunnera arenaria* ..	..	x	x	..	..	x	x	x	..	x	..	x	x	..	..	x sphaero-crystals.
14. *Crantzia lineata* ..	..	x	..	..	..	x	x	x	..	x	..	x	x	..	..	..
15. *Calystegia Soldanella*	..	x	x	..	..	x	x	x	..	x	..	x	..	..	x	..
16. *Coprosma acerosa* ..	..	x	x	x	..	..	x	x	..	..	..	x	..	..	x	x raphides
17. *Cassinia fulvida* ..	..	x	x	..	x	..	x	x	..	..	..	x	..	..	..	..

—	Stereome.			Vascular Bundles.			
	Subepidermal.	In Leaf-margins.	Adjoining Vascular Bundles.	Well differentiated.	Not well developed.	With Mestome Sheath.	With Parenchyma Sheath.
1. *Calamagrostis Billardieri* ..	x	..	x	x	..	x	x
2. *Arundo conspicua*	x	x	x	x	..	x	x
3. *Poa caespitosa*	x	x	x	x	..	x	x
4. *Festuca littoralis*	..	..	..	x	..	x	x
5. *Scirpus nodosus*	x	..	x	x	..	x	x
6. —— *frondosus*	x	x	x	x	..	x	x
7. *Carex pumila*	x	..	x	x	..	x	x
8. *Leptocarpus simplex*	x	..	x	x	x	x	..
9. *Pimelea arenaria*	..	..	..	..	..	..	..
10. *Leptospermum scoparium* ..	..	..	x	x	..	..	x
11. *Epilobium Billardierianum* ..	..	..	..	..	x	..	x
12. —— *nerterioides*	..	..	..	..	x	..	x
13. *Gunnera arenaria*	..	..	..	x	..	..	x
16. *Crantzia lineata*	..	..	..	..	x	..	x
15. *Calystegia Soldanella*	..	..	..	..	..	..	x
16. *Coprosma acerosa*	..	..	..	x	..	..	x
17. *Cassinia fulvida*	..	..	..	..	..	..	x

F. General Conclusions.

1. A good deal of anatomical structure appears which, in the case of the true dune-plants, is mesophytic and antagonistic to their well-being.

2. Certain species are strongly xerophytic in leaf-anatomy—*e.g.*, *Scirpus frondosus*, *Scirpus nodosus*, *Cassinia fulvida*, *Leptocarpus simplex*.

3. In considering adaptation to environment, leaf-anatomy *alone* is not sufficient to decide, but it must be read in conjunction with the special growth-form of the species.

4. A strongly xerophytic growth-form may permit mesophytic leaf-anatomy—*e.g.*, *Pimelea arenaria*, *Calystegia Soldanella*.

5. The plants of the moist hollows for the most part are strong mesophytes, as is natural in their environment; some, however, have xerophytic growth-forms.

6. Be all the above as it may, so far as the New Zealand dune-plants go that have been studied here, there seems to be anatomical structure quite out of harmony with the environment: the xerophytic structure of *Carex pumila*, which grows in moist hollows, may be here instanced.

7. The case of the three active-dune shrubs, *Coprosma acerosa*, *Pimelea arenaria*, and *Cassinia fulvida*, is of interest, since there is a gradual transition, so far as leaf-anatomy goes, from mesophytic to xerophytic, in the order given, and yet they all grow under exactly similar conditions. The three are of distinctly xerophytic habit, but it is certainly worthy of remark that the *Pimelea* and *Cassinia* not only have the advantage over the *Coprosma* in leaf-anatomy, but both have the leaves further protected by tomentum or dense hairs, one of the most efficient of xerophytic adaptations, and extensively common in the indigenous alpine xerophytes. It is not well to generalize from individual cases, but here the anatomical

structure may perhaps be considered rather as a family characteristic than an ecological adaptation.

8. Anatomy and study of growth-forms are by no means sufficient in themselves, but physiological experiments as to transpiration, &c., are demanded, and anatomical studies, although of much moment, are but suggestive, and prepare the way for future research.

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EXPLANATION OF LETTERING IN FIGURES.

air sp.	air-space.	*par. sh.*	parenchyma sheath.
aq.	aqueous tissue.	*ph.*	phloem.
chlor.	chlorenchyma.	*spo.*	spongy parenchyma.
ep.	epidermis.	*st.*	stoma.
g.c.	guard-cell.	*v.b.*	vascular bundle.
h.	hairs.	*xy.*	xylem.
pal.	palisade parenchyma.		

Art. XXVI.—*The Leaf-anatomy of some Trees and Shrubs growing on the Port Hills, Christchurch.*

By Miss L. A. Suckling, M.A.

Communicated by Dr. Charles Chilton.

[*Read before the Philosophical Institute of Canterbury, 6th August, 1913.*]

The following paper contains an account of some of the points in the leaf-anatomy of some trees and shrubs growing in the patches of forest still remaining on the Port Hills, Christchurch. It forms a part of a more comprehensive report on the "Plant Ecology of the Forests on the Port Hills" which was prepared as an honours thesis for the University of New Zealand.

By way of introduction I give a brief description of the district and of its ecological conditions.

I wish to express here my indebtedness to Dr. L. Cockayne, F.R.S., for much assistance readily given in the preparation of the thesis.

Description of the District.

About seven miles south of Christchurch is Lyttelton Harbour, surrounded on its three sides by hills. "Port Hills" is the name given to that part of these hills which lies between Lyttelton and Christchurch, but the name may be extended to include a greater length of hills, stretching more to the south-west, as well as to the east. In this paper the name is used in this extended sense, and includes the part running round the head of the harbour, where the direction changes from east and west behind Lyttelton along the north shore of the harbour, to south-west and north-east till it becomes north and south at the head. To the north and north-east stretch the wide Canterbury Plains, in which Christchurch is situated, while on the south and south-west sides the hills slope down to the harbour, with practically no level ground between. The height above sea-level of the highest peak within the boundaries of the part studied is 593·3 metres, being that of Cass Peak, at Kennedy's Bush, which is taken as the south-west limit. Near the north-east boundary the highest peak is 495·6 metres. The peaks are, as a rule, not much higher than the surrounding hills, the average of which would be from 460 to 530 metres above sea-level. Here and there the hills are rocky.

The part of the district visited lies between Kennedy's Bush or Cass Peak to the south-west, and the Bridle-path to the east. The latter is a road over from Heathcote, a suburb of Christchurch nestling against the hills, to Lyttelton. The forest occurring within these limits may be taken as typical of all of that on the Port Hills.

Ecological Conditions.

(*a.*) *Climate.*

There is no meteorological station at the top of the Port Hills, so that no figures can be given as to the different climatic factors at work there, and it is near the top that most of the bush grows. However, the meteoro-

logical tables at two neighbouring stations have been consulted, and these will give a fair idea of conditions existing where the bush grows. These two stations are in Christchurch City, and at the Convalescent Home on the Port Hills, which is situated about 50 metres above sea-level.

Rainfall in Christchurch throughout the year is, on the whole, fairly evenly distributed, but on an average most rain seems to fall in July. The mean rainfall for July for the years 1902–10, inclusive, was 7·820 cm. The rainfall each month seems to vary considerably for each year, sometimes one month being the wettest one year and perhaps the driest the next. The average annual rainfall is about 85 cm., or a little over. The number of days with rain seems to be more equal for each month than the actual rainfall. The mean total number of days with rain from 1902 to 1910 for the winter months (June, July, August) was 38·8 ; for September, October. and November, 29·5 ; for summer (December, January, February), 26·1 for autumn (March, April, May), 31·9. Comparison of records taken in Christchurch with those taken at the Convalescent Home shows that there is a considerable amount of difference in the two stations, and that there is some variation in relative amount of rainfall, that at Christchurch being sometimes less, sometimes more, than at the Home. For instance, in July, 1910, the total rainfall for the month in Christchurch was 15·10 cm., while that on the hills was only 11·40 cm. Again, for August, 1907, Christchurch showed a total of 7·225 cm. ; the hills, 12·525 cm. On the whole, rainfall is rather less at the Convalescent Home than in the city, but is probably greater higher up the hill than it is at the foot. When an easterly wind is blowing, on a clear day, clouds often hang over the spurs of the hills. In summer, and sometimes in winter, dry hot north-westerly winds blowing against the northern slopes of the hills must affect the amount of moisture in the soil.

Schimper* says that from an ecological point of view statistics as to temperature should give the mean daily minimum and maximum for each month of the year. These, however, are not available at the meteorological stations referred to ; only the mean temperature for each month can be given, as a rule. At Lincoln, a station south of Christchurch and some few miles from the hills, the highest temperature recorded in 1903 was 83·8° F., in November ; the lowest, 22·0° F., in July. The temperature for the different months does not differ so much in different years as does the rainfall. The coldest months are from May to September, with an average temperature of about 47° F. ; the hottest, from November to February, with an average of about 59° F.

The temperature readings at the Convalescent Home are not taken in the same way as at the stations at Christchurch and Lincoln, and so are of no value for comparison. However, readings have been taken by residents near the Home, and these show that the temperature is slightly higher there than on the plains. There are fewer frosts near the foot of the hills than in Christchurch, but it is probably colder higher up than it is nearer the foot, for in winter snow often appears sooner near the top, and lies longer. For instance, on the 20th September, 1911, there was snow lying at the top, but none farther down.

The only statistics for relative humidity, and force and frequency of winds, are taken from Dr. Cockayne's paper on the Waimakariri River

* Schimper, A. F. W. : "Plant Geography." Translated by W. R. Fisher. 1903. p. 175.

Basin,* and these were recorded some years ago. The force of the wind may be seen by records of the average daily force in miles for the year and of the maximum velocity in miles on any day in the year. For the years 1874 to 1879, inclusive, the average daily force for the year was 127 miles; the maximum velocity for a day, 717·5 miles. The most frequent wind, according to statistics, is the south-west, which is common in winter, and is a cold, strong wind, blowing in gusts, and generally bringing rain. The south side of the hills especially gets the full force of this wind. In summer it usually follows a north-west wind, bringing a heavy storm, and greatly lowering the temperature of the atmosphere. Though statistics show that the south-west is the most frequent wind, the east wind is generally considered to be the most prevalent, and addition of figures of frequency of the north-east, east, and south-east winds shows that the prevailing wind is from the east, though not always blowing from due east. The east wind, whether north-east, east, or south-east, is always steady, and often strong, but never blowing in gusts. Neither side of the hills is protected from it. A fairly frequent wind is the north-west, which is a great contrast to the south-west, which in summer it often precedes. It is a strong, gusty wind, laden with rain before it reaches the Southern Alps, but hot and dry after it has deposited the moisture on the mountains and sweeps across the plains to the east coast. The north-wester blows with force against the north side of the hills, and has a very drying effect. The average daily maximum relative humidity for the month before 1877 was in July, with 83, and minimum in October, with 72.

Some idea of the amount of sunshine may be obtained from the number of days with rain. New Zealand sees more of the sun than does Great Britain. For example, during 1902 there were 1,492·2 hours of sunshine in Surrey, one of the sunniest parts of England, and 1,749·59 hours in Christchurch. The light outside the bush, affecting the foliage of the trees, is more intense than that reaching the lower leaves of the trees, the shrubs, and the herbs, but in most places the light in the interior of the forest on the hills is not very diffuse.

Another factor important in a study of plant-ecology is the altitude of the habitat. The average height of the hills, as stated above, would be between 460 and 530 metres above sea-level.

(*b.*) *Edaphic.*

The soil varies considerably in physical and chemical character in different parts. Where there are no rocks near the surface the soil is a light loam for about half a metre or so, varying slightly as to depth, and below this there is clay. In some parts the substratum is composed mostly of small rocks with some soil between. This unevenness seems to serve a good purpose, or animals are not so fond of entering the "bush" and destroying the undergrowth; so that where the substratum is rocky ferns seem to be more abundant than in other places where animals are not kept out. Most of the species seem able to grow on or between the rocks about as well as in the deep soil. The clay would increase the water-capacity of the soil, which, since it forms a sloping surface, would be inclined to allow the water to run away.

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* Cockayne, L.: "Plant Geography of the Waimakariri River Basin." Trans. N.Z. Inst., vol. 32, p. 95.

LEAF-ANATOMY.

The plants of which the leaf-anatomy was studied were selected as representatives of the following plant-forms: (1) Lianes, (2) deciduous trees, (3) evergreen trees, (4) semi-parasites.

Parsonsia heterophylla A. Cunn.

This plant is a liane all through its life, not assuming different habits, but the leaves at different ages are of most diverse shapes. There are all transitions, from orbicular to linear, oblong, and partly lobed. The leaf of the mature plant is oblong or ovate, subacute, entire, varying in size from 4 m. to 8 m. long, 2 m. to 3 cm. broad, and may have a few hairs on the upper surface, which the young leaves seldom have. There is no essential difference in the anatomy of the young and adult leaf, but in the former often the row of cells next to the lower and upper epidermes contains anthocyan as well as chloropyhll, and this gives the leaf a copper-coloured appearance. (See fig. 1.)

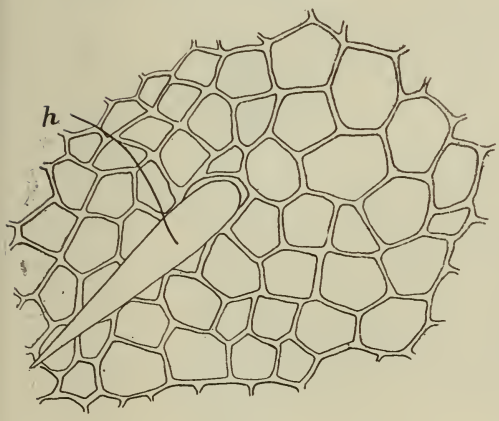

FIG. 1.

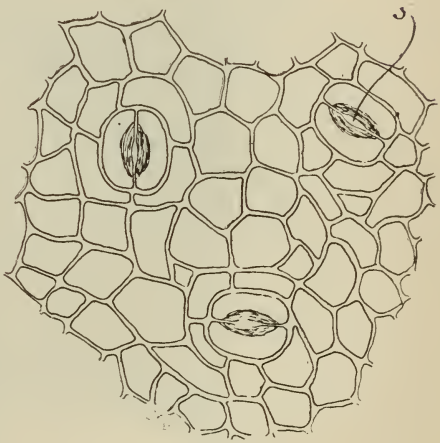

FIG. 2.

FIG. 1.—Upper epidermis of *Parsonsia heterophylla* leaf, showing hair; × 418.
FIG. 2.—Lower epidermis of same; × 418.

Leaf-anatomy.—The leaf-anatomy of one of the lianes, *Parsonsia heterophylla*, was studied, and compared with that of *Tetrapathaea australis*, with a view to finding in them some of the anatomical characters peculiar to climbers.

The epidermis is covered with a thick striated cuticle, and is composed of rather large cells. Unicellular hairs often occur on the upper and sometimes on the lower surface, but not thickly enough to affect transpiration. These hairs take on a bright-red colour with eosin, while the other epidermal cells remain unstained. The epidermis is two-layered above the midrib. Stomata occur only on the lower surface, with which they are level.

The palisade layer is three or four cells deep, tightly packed, with chlorophyll grains distributed throughout the cell. Each cell contains a conspicuous oil-drop, soluble in ether. The palisade tissue composes about a quarter or one-third of the thickness of the leaf. The cells of the spongy parenchyma are loosely arranged, and contain fewer chloroplasts than the

palisade layer, except near the lower epidermis. Rounded masses of crystals of calcium oxalate occur fairly abundantly in the spongy parenchyma.

The midrib is surrounded by round-celled parenchyma, amongst which, directly above and below the xylem-strands, and close to the latter generally, occur little groups of small cells. These may be part or all of the phloem, which Solereder* says occur in the stem on the inside of the xylem, and in groups in the pith, as well as outside the xylem. Staining with

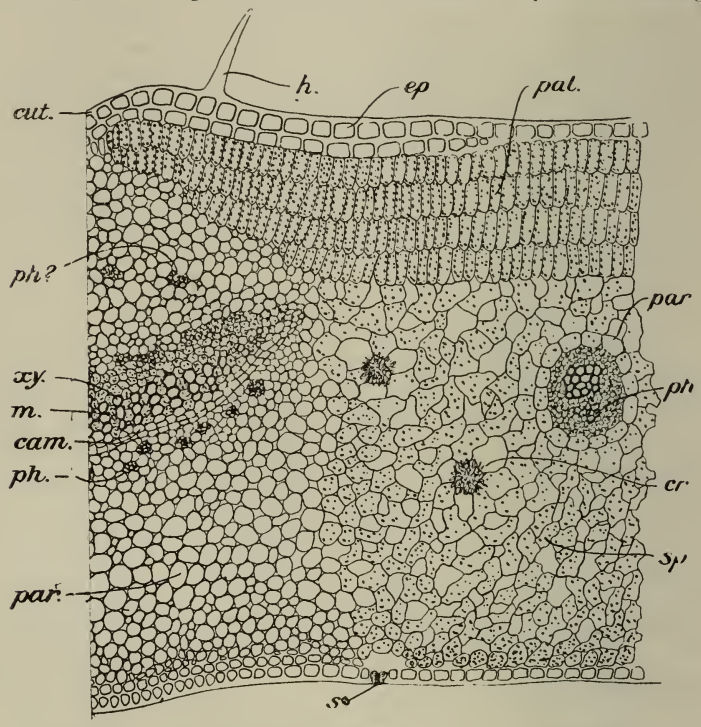

FIG. 3.—T.S. of adult leaf of *Parsonsia heterophylla*, passing through part of the midrib. The groups of small cells in the midrib are probably phloem. × 167.

eosin failed to prove the presence of sieve-tubes. In the mesophyll the vascular bundles are surrounded by large parenchyma cells, which contain chlorophyll.

Leaves of the young stage of this species often contain a red colouring-matter, besides the chlorophyll, in the upper row of the palisade cells and in the lowest of the spongy parenchyma cells. This colouring-matter is soluble in alcohol, dissolving out and leaving the green chloroplasts. It answered tests for anthocyanin, being changed to a blue by a strong base.

There is no other difference in the anatomy of the adult and juvenile leaf-form.

The anatomical characters of the leaf of *Parsonsia heterophylla* seem to be altogether mesophytic, and there seems to be little device to protect against or to increase the effect of radiation, except the fairly thick

*Solereder, H.: "Systematic Anatomy of the Dicotyledons." Translated by L. A. Boodle and F. E. Fritsch, vol. 1, p. 531.

cuticle. This leaf might easily be taken as a typical mesophytic leaf. The leaf of *Tetrapathaea australis* is very similar to that of the former in essential ecological characters. It also has crystals of calcium oxalate in the mesophyll; but this point is more of morphological interest, common in the family to which it belongs. The cuticle is not quite so thick as in *Parsonsia*. (See figs. 1, 2, and 3.)

Fuchsia excorticata Linn. f.

Fuchsia excorticata Linn. f. is very abundant, and is found in all stations, out in the open and in the thick bush, in the latter case often forming a much larger tree than it ever does in exposed positions. It often roots amongst rocks, the roots growing along close to the rock and fastening

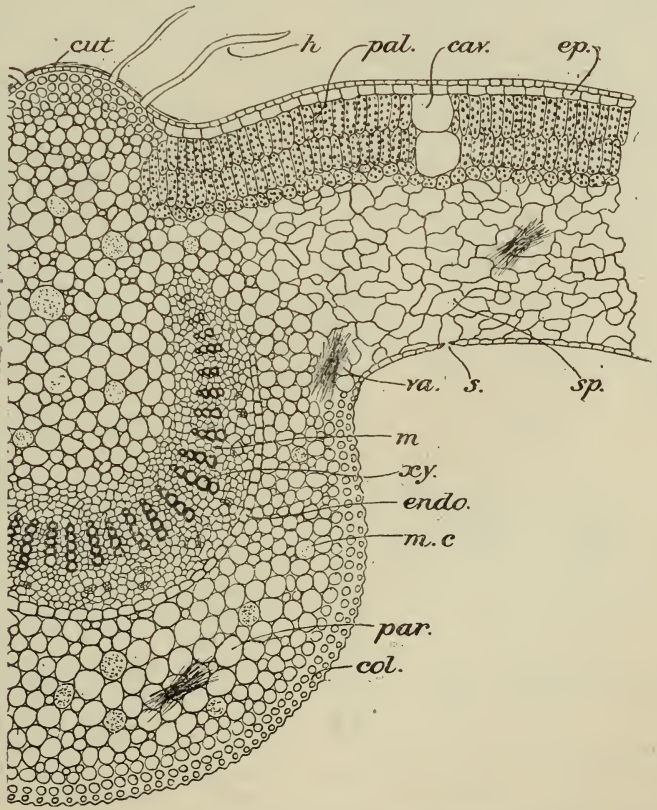

FIG. 4.—T.S. through the leaf of *Fuchsia excorticata*, passing through the midrib; × 60.

in the crevices. In habit it is somewhat peculiar, the trunk being often almost quite horizontal for some distance, very irregular, and much branched, sometimes over 3 m. round at the base. Leaves, which are silvery underneath because chlorophyll is absent in the spongy parenchyma, are lost in May, and appear in August, which is also the beginning of the flowering season.

Leaf-anatomy.—The epidermis has little or no cuticle. It gives off a few unicellular trichomes, especially above the midrib. It consists of two layers of cells on the upper surface, except above the midrib, and both are without chlorophyll, and contain oil-drops. The cells of the outer layer are very wavy in outline as seen from surface view. Stomata are present only on the lower surface, where they are numerous, and are on a level with the other epidermal cells. They are not provided with special auxiliary cells.

The palisade layer is two or three cells deep, the third often consisting of rounded cells. It contains abundant chlorophyll, and measures about one-third the whole thickness of the leaf. The spongy parenchyma contains a large amount of air-space, and in the mature leaf is devoid of chlorophyll, giving the latter a silvery appearance on the under-surface.

Large cavities, with thin or no special bounding walls, occur at fairly regular intervals in the palisade layer. Bundles of raphides of calcium oxalate are abundant in the spongy parenchyma of the midrib.

The vascular bundle of the midrib is surrounded by large parenchyma cells, many of which contain mucilage, while raphides are found in a few. Anthocyan may occur in the epidermis above the midrib.

The raphides are probably a waste product, stored in the leaves, and got rid of when the leaf falls. Since the leaves are not on the tree when it is exposed to cold dry winds, at a time when root-activity is not so great, this may possibly be the reason why they have not developed a thick cuticle to protect against excessive transpiration. The leaf-anatomy of *Fuchsia excorticata* has several points in common with that of *Plagianthus betulinus*, the other deciduous tree on the Port Hills. Both have crystals of calcium oxalate in the mesophyll of the leaves, those of the latter being similar to the crystals in the leaf of *Parsonsia*. The cuticle of *Plagianthus* is also rather thin, and in its palisade layer are cavities or large empty cells, very similar to those of the *Fuchsia* leaf. Both leaves contain abundance of mucilage when the leaf is ready to fall, and also in *Plagianthus* when it is quite young. The occurrence of mucilage in *Plagianthus* is probably a character of systematic importance, however, and is not specially produced owing to the deciduous habit, as it is common in the family *Malvaceae*, according to Solereder.* Crystals also are common in most of the members of the two families *Onagraceae* and *Malvaceae*. No mention is made by Solereder of the cavities in the palisade layer of the leaves of these two species. (See figs. 4 and 5.)

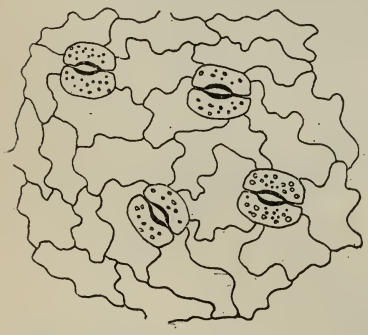

Fig. 5.—Lower epidermis of leaf of *Fuchsia excorticata*; × 250.

Olearia Forsteri Hook. f.

This is a small tree, occurring only in the bush. It has a stringy bark. The leaves are leathery, and have a thick tomentum on the lower surface.

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* Solereder, H.: "Systematic Anatomy of the Dicotyledons." Translated by L. A. Boodle and F. E. Fritsch, vol. 1, p. 146.

When specimens of this tree are grown in the open, in gardens, the leaves are a little smaller, rather curled up, and of a brighter yellowish-green.

Leaf-anatomy.—The upper epidermis is covered with a fairly thick cuticle. If the upper epidermis be stripped off and stained with haematoxylin, the cuticle remains colourless, and can be seen to have small openings here and there, surrounded often by markings which seem to be arranged in the shape resembling the guard-cells of stomata. Over the opening is a collection of a granular or scale-like substance, looking like broken pieces of the cuticle, which it probably is, since it turns yellowish-brown with chlor-zinc-iodide, and yellow in caustic potash, and is hardly soluble in chromic acid. It is not wax, being insoluble in ether. To the naked eye it appears on the upper surface of the leaf as a white granular substance. The upper epidermis is two cells thick, the inner cells being larger than the outer, and with the outer sometimes containing chlorophyll. The transverse walls of the outer epidermal cells have conspicuous pits. The lower epidermis is one cell

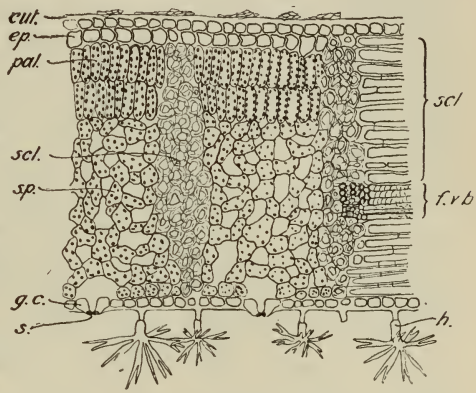

FIG. 6.—T.S. through the leaf of *Olearia Forsteri*, with some of the stellate hairs on the under-surface showing; × 75.

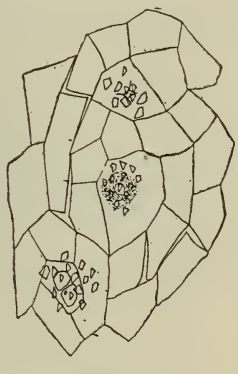

FIG. 7.

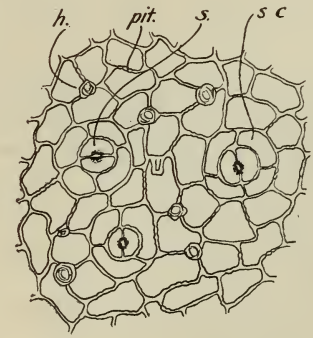

FIG. 8.

FIG. 7.—Cuticle from the upper surface of *Olearia Forsteri*; × 85.
FIG. 8.—Lower epidermis of the same, with the tops of the hairs removed; × 85.

thick, and its cells resemble those of the upper, and also have a thick cuticle. It is thickly covered with a layer of buff-coloured, two-celled stellate hairs growing from the epidermal cells. The stomata are raised above the other epidermal cells, and have large subsidiary cells.

The palisade layer is generally two cells thick, and about one-quarter of the thickness of the leaf. The spongy parenchyma forms a rather deep layer, and both it and the palisade layer contain abundant chlorophyll. The cells of the mesophyll contain conspicuous oil-drops, usually one in each cell. Bands of sclerenchyma occur at short intervals, extending from one epidermis to the other, and also above and below the vascular bundles. Pits can be easily seen in the walls of the sclerenchyma cells. The sclerenchyma assumes a very bright tint with iodine-green or saffranin. Below the vascular bundles of the midrib there are one or two canals.

A study of the anatomy of this leaf reveals several xerophytic characters. There is abundance of sclerenchyma, which makes the leaf very leathery. The thickness of the cuticle, the possession of a double epidermis (probably for water-storing purposes), and the great thickness of tomentum of empty hairs on the lower surface, where the stomata occur, are all common in plants adapted to dry situations. The position of the stomata above the surface of the epidermis would seem to show that the hairy covering is sufficiently effective in decreasing transpiration, and no further device, such as sinking of the stomata, is necessary.

Sections were made of leaves from garden specimens growing in an exposed, sunny position. The only marked difference in the anatomy was the far smaller amount of oil in the mesophyll of the garden-plant than in that of the forest-tree. No different arrangement of chloroplasts in the cells of the palisade layer could be detected, for in both cases they seemed to occur throughout the cell, and not only on the walls. (See figs. 6, 7, 8.)

Griselinia littoralis Raoul.

Griselinia littoralis Raoul, the broadleaf, is common in the bush and in the open. There are some very ancient trees of this species on the hills. One measured 4·75 m. in circumference. It has large buttress roots.

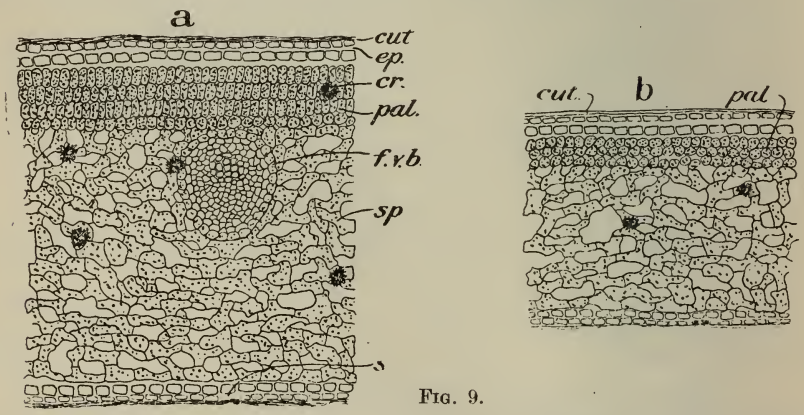

Fig. 9.

Fig. 9.—(*a.*) T.S. through leaf from a well-illuminated position on a tree of *Griselinia littoralis.* (*b.*) T.S. through leaf from a young tree growing in a shady position in the bush. Both × 60.

Leaf-anatomy.—This species grows into a comparatively large tree on the hills, and the leaves are, as a rule, fairly well illuminated. Leaves were taken and examined both from amongst those of a large tree and

from a young tree growing in a rather damp, shady situation. The following is a description of the anatomy of the first :—

Epidermis : The cuticle is conspicuous, and of a bright-green colour on both surfaces, and both lower and upper epidermes are double, the inner cells being larger than the outer. Stomata are numerous, small, only in the lower epidermis, difficult to see in transverse section. The guard-cells contain oil-drops, and have no special subsidiary cells. Hairs are altogether absent.

Mesophyll : The palisade layer is three or four cells deep, the cells being rather small, and containing abundant chloroplasts distributed throughout the contents of each cell, not arranged along the walls. The spongy parenchyma is rather deep, with the average amount of air-space, and the chloroplasts are not quite so abundant as in the palisade layer. No sclerenchyma is developed in the leaf. Clusters of crystals of calcium oxalate occur in the mesophyll. (See fig. 9, *a*, *b*.)

The leaves taken from a shady position were much thinner. The cells of the palisade layer were rounded, but about the same size as in the former case, and more loosely packed. Air-spaces were a little more numerous, perhaps, but this was not so well marked as the difference in the palisade layer. The cuticle was slightly thinner, and colourless.

Tupeia antarctica Cham. & Schl.

Tupeia antarctica Cham. & Sol. is perhaps the most abundant of the three semi-parasites present. It is a shrub of about the same size and habit as *Loranthus micranthus*, but has smaller leaves, variable in size, of brighter colour, and also isobilateral.

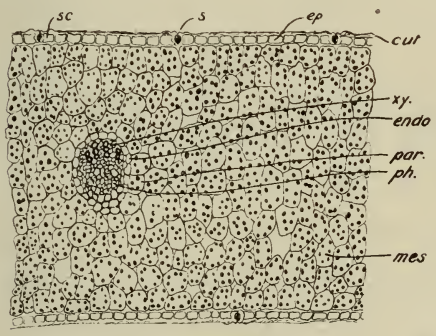

FIG. 10.

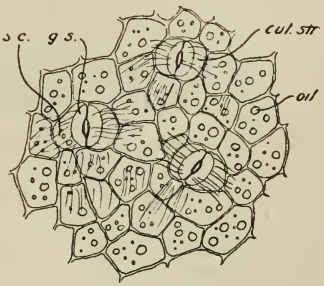

FIG. 11.

FIG. 10.—T.S. of the leaf of *Tupeia antarctica* ; × 40.
FIG. 11.—Epidermis of the same ; × 150.

Leaf-anatomy.—The leaf-anatomy of *Tupeia antarctica* and of *Loranthus micranthus* seem to be very similar, but this may be due to their belonging to the same family as much as to their having adopted the same mode of life.

The leaf of *Tupeia antarctica* is isobilateral, and shows no differentiation of mesophyll into palisade layer and spongy parenchyma. The cuticle is thick, and striated, especially near the stomata. The epidermis is com-

posed of a single layer of cells with conspicuous oil-dops, and numerous stomata, present on both surfaces, each with two subsidiary cells, and level with the other epidermal cells. The mesophyll is composed of green cells with few air-spaces. The parenchyma cells surrounding the vascular bunches contain a little chlorophyll. In being thick and isobilateral, and in having a small amount of air-space, the leaf shows characters of a heliophyll.

EXPLANATION OF LETTERING IN FIGURES.

cam.	cambium.	*mes.*	mesophyll.
cav.	cavity.	*oil*	oil-drops.
col.	collenchyma.	*pal.*	palisade layer
cr.	crystals.	*par.*	parenchyma.
cut.	cuticle.	*ph.*	phloem.
cut. str.	striated cuticle.	*pit.*	pit.
endo.	endodermis.	*ra.*	raphides.
ep.	epidermis.	*s.*	stoma.
f.v.b.	fibro-vascular bundle.	*s.c.*	subsidiary cell
g.c.	guard-cell	*scl.*	sclerenchyma.
h.	hair.	*sp.*	spongy parenchyma.
m.	medullary ray.	*xy.*	xylem.
m.c.	mucilage cell.		

Art. XXVII. — *The Nomenclature of the Birds of New Zealand: being an Abstract of Mathews and Iredale's "Reference List."*

By Professor Benham, M.A., D.Sc., F.R.S.

[*Read before the Otago Institute, 7th October, 1913.*]

An important paper on the names of our birds was published in the *Ibis* for April and July of this year, by Messrs. G. M. Mathews and Tom Iredale, under the title of "A Reference List of the Birds of New Zealand," which deserves to be summarized for the use of our naturalists to whom that journal may be difficult of access.

The authors have been able to examine a large series of almost all the species enumerated by Buller in the Supplement to his "Birds of New Zealand," which contains a complete list of all the birds, native and visiting, which have been recorded as occurring in our islands or seas. At the same time they have been in a position to examine critically the literature in a way that was impossible to the early workers in this country. Further, in many cases the original specimens, or "types," have been compared with the descriptions given by the zoologists by whom the specimens were named; and it appears, in short, that no trouble has been spared to make this new list as correct and complete as possible.

In the case of each species and subspecies, only sufficient synonymy has been given as will enable one to identify it with the bird described or listed by Buller, where the full synonymy will be found.

It will be seen from List I appended at the end of this article (p. 194) that a good number of the generic names have been altered : names familiar to us in New Zealand have had to give way to others. The reasons for these changes are, firstly, that the authors hold very rigidly to the law of priority ; secondly, they take as the starting-point for valid names the tenth edition of Linné's "Systema Naturae," published in 1758, instead of the twelfth edition, of 1766, which until recently has been the foundation of the binomial system of nomenclature usually followed. Again, some of the work of our early ornithologists in New Zealand was "little more than guesswork," especially in regard to the sea-birds, for much of the literature was difficult of access here.

The authors adopt the trinomial system, and this is the first instance of its application in New Zealand to any group of animals, except that Iredale has used it in his "List of the Birds of the Kermadec Islands."*

It will be seen from a few examples that this is a very useful innovation, in that it indicates at once the close affinity between the different forms or subspecies of one and the same species which inhabit the different islands that constitute the New Zealand area. Systematic work in all groups nowadays is more and more closely correlated with geographical distribution than it used to be ; and, as classification is the expression of genetic relationships, the utility to the evolutionist of this trinomial system becomes manifest. Thus, the tui, *Prosthemadera novae-zealandiae*, as we have hitherto called it, occurs on both the North and South Islands (as well as Stewart Island) and on the Auckland Islands. Under the new scheme each of these local forms or subspecies receives its own distinctive name—the South Island tui, since it was the first to be described, is *Prosthemadera novae-seelandiae novaeseelandiae ;* that on the North Island is *P. novaeseelandiae phoebe ;* and the Auckland Island form is *P. novaeseelandiae kwini.*†

The authors, I may mention, pay very special attention to the exact spelling of the generic and specific names: in whatever form they were originally spelt, apart from evident *lapsae calami*, the rules of nomenclature demand that that form must be retained. Thus Sparrman wrote "novaezelandiae" ; Gmelin used the form "novaeseelandiae" ; while Quoy and Gaimard preferred "novae-zealandiae." Some years ago our naturalists attempted to adopt some uniform spelling for this word, but the law of priority does not allow this uniformity.

As with the tui, so with the bell-bird, of which four subspecies are now recognized ; and the same means are employed for distinguishing the local forms of kiwis, kingfishers, fantails, and other birds of the North and South Islands. In most cases the distinction was either not made formerly, or the two or more forms were regarded as so many distinct species. These are now recognizable as merely subspecies of one and the same species, and their relationship is thus better appreciated. This comes out very strikingly in the case of our shags, as may be seen by examining List II appended (pp. 195–202), in which the breeding-place of each subspecies is given.

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* Trans. N.Z. Inst., vol. 45, 1913, p. 78.

† The choice of the names for these two subspecies is perhaps not as suitable as would have been the case had they been bestowed by a naturalist in this country ; but, after all, names are only labels, and need not have any meaning.

The use of the third name also allows the affinity to be expressed between the form of a bird occurring in New Zealand and that on which the species was founded. For instance, our black-backed gull is now termed *Larus dominicanus antipodus*, for the "type-locality," or locality at which the type or first example of the species was recorded or breeds, is South America; and it becomes useful—and, indeed, desirable—to emphasize its affinity with the American species, and at the same time to indicate that the bird breeds in New Zealand, and differs in some slight details, perhaps, from the type. So with our crested grebe: the type-locality of *Podiceps cristatus* is Sweden, while our form differs in certain respects from it, but is not worthy of a separate specific name, and the facts are indicated by the addition to the specific name of a third or subspecific title, "*australis.*" The penguin (*Pygoscelis papua*) was originally described from the Falkland Islands, whilst our bird breeds on the Macquaries, and is termed *Pygoscelis papua taeniata*, or, in short, *P. p. taeniata.* And this is the case with many of our sea-birds.

Amongst the few changes in specific names, reference may be made to the ugly subspecific name "*matook*" which has been added to *Demiegretta sacra;* while the royal albatross from Campbell Island is no longer *Diomedea regia*, but *D. epomophora epomophora.* Our familiar *Circus gouldi* becomes *C. approximans drummondi*, and the Caspian tern is now *Hydroprogne tschegrava oliveri.*

Throughout the "Reference List" the authors give the breeding-place within our area, and when necessary the breeding-place of the type, as in the case of the sea-birds. There is still a good deal of confusion as to some of the sea-birds that have been recorded from our seas, which the authors have been unable fully to set at rest owing to the absence of the specimens on which the record was founded, some of these being in museums of the Dominion, and thus inaccessible to the authors in England. This is true, too, of several of the visiting *Charadriidae.*

There is an interesting historical note in regard to Sparrman, whose name appears after several of our species. It appears that he was a salaried assistant of Forster's on Cook's second voyage; his collection must, therefore, have been made under Forster's supervision, and probably after the latter had selected what he wished for his own work. But Sparrman, unfortunately, mixed up the localities of several of the birds described by him: thus he attributes to some of them "Cape of Good Hope"—*e.g.*, the rifleman and South Island thrush. It therefore became important to fix the localities of these types, and the authors do so by reference to "what is absolutely known from Forster's descriptions and from George Forster's drawings." But the retention of Sparrman's names leads in some instances, as I point out below, to alterations in familiar names which are to be regretted.

Perhaps to most people the changes in the generic names will be most noticed, and there is nothing that annoys naturalists, more especially amateur naturalists, to whom the professional owes so much for his knowledge of animals of all groups—nothing annoys them more than alterations in the names to which they have been accustomed for years, and it is distinctly disheartening to young naturalists; but in most cases these changes are unavoidable. Rules have been formulated for the proper method of naming animals, and it is not from "pure cussedness" that alterations are made. For instance, if in digging into the literature it is found that a bird has at some previous date been given a name other than that by which

it has been customary to call it, then by the law of priority that latter name must give way to the earlier-bestowed name; or, on the other hand, if a name in general use for a given bird turns out on investigation to have been given at an earlier date to a bird of quite a different character, then some later name must be substituted for the former bird. This is well illustrated by our woodhens (Maori hens, or wekas): the generic name *Ocydromus*, by which the birds have been hitherto known to us, is found to be "untenable, being preoccupied"—that is, Iredale by an exhaustive examination of the literature has discovered that at some previous date this name had been used for quite another bird; hence it becomes "untenable" for our woodhens, or, indeed, for any other animal whatsoever ("Novitates Zoologicae," vol. 18, 1911, p. 22). The name next later in date to this is found to be *Gallirallus*, which had fallen into oblivion, and now has to be revived. The authors go fully into the difficulties of determining the exact names of the species of our woodhens. The result of their analysis is that "*Gallirallus australis* ranges throughout the North, South, and Stewart Islands, but in slightly differentiated subspecific forms."

The stitch-bird is no longer *Pogonornis;* that name is preoccupied as appears to have been noted by Richmond in 1908, and is replaced by *Notiomystis.*

I do not know on what grounds *Notornis* is regarded as incorrect for the species *hochstetteri.* According to the International Committee, the name is to be retained for the extinct form, *Notornis mantelli*, and though Meyer long ago showed that the living species of the South Island is worthy of distinct specific recognition no such important differences were mentioned as to indicate that there is a generic difference between the two. But according to our authors "*Notornis*" must disappear, and be replaced by a new name, "*Mantellornis.*" They say, "Mathews has gone fully into the matter of the generic and specific names of this bird" (as he has of other birds) in his work "Birds of Australia," 1911, 1912; and in this "Reference List" these reasons are not given in full, or only in a few instances. As the "Birds of Australia" is not accessible to me, it is impossible for me to give Mathews's reasons for this particular change.

The little rifleman (*Acanthisitta chloris*) receives as much as two pages and a half of discussion on its generic and specific names; and amidst much confusion the fact is brought out that Sparrman gave as the locality "Cape of Good Hope" to the specimens collected by Forster at Dusky Sound. Fortunately, he did not add to the confusion by using a specific name that would perpetuate this error.

In most instances, however, the matter, having been treated previously either by Mathews or by Iredale in earlier papers, is not dealt with in detail in this article.

It will be seen from the lists appended (pp. 194–202) that in several instances a single genus has been broken up into two or more genera: thus some of the species which have been attributed to the genus *Oestrelata* are now placed in the genus *Pterodroma*, others in *Cookilaria*, both of which were founded as long ago as 1856, but which seem to have been overlooked by our naturalists in New Zealand.

The genus *Phalacrocorax* is broken up into five genera, one of which must retain Linné's name; three others have been established for something like fifty years, and one is formed now by the authors.

The genus *Prion* is found to be "indeterminable"—it is insufficiently characterized by its author, Lacepede; and some of the species formerly

included in it are ranged under *Pachyptila*, more than one hundred years old ; others to *Pseudoprion* and *Heteroprion*, of later dates.

Our warblers, hitherto placed in the genus *Pseudogerygone*, are found by careful comparison with members of that genus to differ sufficiently from it to warrant the formation of two new genera—*Maorigerygone* and *Hapolorhynchus*.

It is, of course, impossible for me to give the reasons for these various changes, or to discuss their correctness or otherwise. These authors have had opportunities denied to us in our isolation. We must accept their conclusions as well founded—at any rate, in most instances—till some other ornithologist in Europe shows reasons against them.

But there are one or two cases at least in which it seems to me that the alterations are open to criticism. For example, the New Zealand crows belong to a genus confined to the main islands of New Zealand, of which only two species are known. In the "Catalogue of the Birds in the British Museum," vol. 3, written in 1877 by Bowdler Sharpe, we find that two generic names are given as having been bestowed on these crows—*Glaucopis* Gmelin, 1788, and *Callaeas* Forster, 1844. Sharpe retains the earlier name, and we have always known our crows as *Glaucopis*. Now Mathews and Iredale date *Callaeas* as 1788 (how is it that Sharpe did not know this ?) ; but even if this be so—and I have no reason to doubt the correctness of this statement—yet the general zoologist, who is not obsessed by the desire for change for the sake of adhering slavishly to the law of priority, cannot refrain from asking, What benefit to ornithological literature results from ringing the changes on these two names ? *Glaucopis* has been in use, apparently unchallenged, for 125 years ; and even if *Callaeas* was invented in the same year as *Glaucopis*, what harm can possibly arise by leaving *Callaeas* in its long sleep, buried away in some presumably un-get-at-able publication, for, as I have noted, Sharpe seems to have overlooked its earlier date ? What advantage to any zoologist is attained by thus substituting the name *Callaeas* for the well-known *Glaucopis ?* The genus is endemic, and confined to this country ; it is quite isolated ; and the name *Gluacopis* has the authority of the British Museum catalogue. It seems a needless alteration.

Again, the huia belongs to a genus with a single species, confined to New Zealand (North Island). Hitherto we have called it *Heteralocha acutirostris*, and though Sharpe, in his catalogue, clearly recognized that Gould's name of *Neomorpha* (1837) precedes that of Cabanis (1851), yet he retains the later name, *Heteralocha*. *Neomorpha* Gould appears to have been discarded because a genus of cuckoo had already been named *Neomorphus* by Gluger in 1827. It is therefore not clear why these authors have resuscitated Gould's name.

Another unfortunate change is that in the specific name of our South Island thrush, hitherto known as *Turnagra crassirostris*. It appears that the name bestowed on the original specimens by Sparrman was *T. capensis*, owing to a mistake in his labels, so that he attributed the bird to the Cape of Good Hope. It is only as a result of the investigations of these authors that it has been found possible to identify these names of Sparrman's with those of Forster. Here again one feels inclined to grumble at the strict application of the law of priority, for the genus is confined to New Zealand, has only the two species, and no sort of conceivable convenience arises from this change, while all kinds of misconceptions and inconveniences may arise in the minds of readers of ornithological works when such a geo-

graphical term is found to belong to a bird living half the circumference of the globe away from the Cape. No sort of inconvenience would result were this name *capensis* ignored. One feels a deep regret that these authors have done their work so conscientiously and thoroughly.

We must, of course, fully recognize the importance of adhering to the rules of nomenclature, but in cases such as these three birds surely some advantage to the naturalists (especially in New Zealand) is sacrificed to a strict adherence to the law of priority, and no corresponding advantage, it seems to me, is gained by the ornithologist. These sticklers for priority ignore the fact that the various books dealing with natural history generally, works on general zoology and on geographical distribution and other cognate subjects, in which these birds (and the same applies, of course, to other groups of animals) are referred to in illustration of habit, or structure, or habitat, or adaptation, &c., become puzzling or meaningless to later generations of readers when well-established names are thus altered by specialists who have been able to delve a little deeper into the pamphlets of the past. Some of us general zoologists who have to keep abreast of several groups in the interests of our students feel that some sort of statute of limitation is needed, and welcome some controlling influence such as is being evolved by the International Commission on Nomenclature.

This leads on to another matter. Since the publication of the "Reference List" there has appeared in the *Zoologischer Anzeiger*, for the 26th September, 1913, a report by an International Committee of Ornithologists recommending a list of generic names of birds as "valid and to be accepted" by all ornithologists. In this list I notice two names which Mathews and Iredale had proposed to alter—viz., *Phalacrocorax*, with type *P. carbo*, Linné; *Himantopus*, with type *H. himantopus*, Linné. This being the case, we must in obedience to this Commission on Nomenclature retain these two generic names in spite of the investigations of Mathews and Iredale, who suggest that in place of them should be substituted *Carbo* and *Hypsibates* respectively. In the list appended I have followed the committee's ruling.

International committees have been set up by the Commission for the consideration of lists of names in the various classes of the animal kingdom which naturalists deem it desirable or advantageous should be retained in spite of the rule of priority. It is quite possible that the committee would, if the matter were referred to them, decide in favour of retaining *Glaucopis* and *Heteralocha*.*

Again and again the authors emphasize the need of a careful study of a good series of specimens, with well-authenticated localities, before it is possible to decide finally on the distinction of certain of the subspecies, such as the warblers, hawks, kakapos, nestors, shags, &c. It is, however, to be feared that this desideratum will be difficult to attain, for, since every land-bird is now protected by Order in Council, it is very difficult, if not impossible, to obtain anything like a good series for careful investigation. The specimens in the private collections up and down the country are not always, it is to be feared, properly "localized": many of the localities are only preserved in the memory of their possessors.

I append three lists—I. A list of changes in generic names. II. A complete list of the birds which are constantly to be found within the New Zealand area, most of which are known to breed therein. III. A list of occasional visitors.

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* I have submitted these names to the consideration of the committee.

List I.—In this list I have arranged in alphabetical order on the left side the names as they appear in the "Index Faunae Novae-Zealandiae," and on the right side of the page are the new names as proposed in the "Reference List," with the names of their authors and dates.

LIST I.—NEW GENERIC NAMES AND CHANGES IN GENERIC NAMES OF NEW ZEALAND BIRDS, ARRANGED IN ALPHABETICAL ORDER.

"Index Faunae Novae-Zealandiae."	"Reference List."
Acanthidositta	*Acanthisitta* Lafresnaye, 1842.
Ardetta	*Ixobrychus* Billberg, 1828.
Certhiparus (part)	*Finschia* Hutton, 1903.
Chalcococcyx	*Lamprococcyx* Cabanis, 1862.
Diomedea sp. (mollymawks)	*Thalassarche* Reichenbach, 1852.
Gallinago	*Coenocorypha* Gray, 1855.
Glaucopis	*Callaeas* Forster, 1788.
Halcyon	*Sauropatis* Cabanis and Heine, 1860.
Heteralocha	*Neomorpha* Gould, 1857.
*Himantopus**	*Hypsibates* Nitzsch, 1827.
Larus (part: smaller species)	*Bruchigavia* Bonaparte, 1857.
Mahua (laps. cal.)	*Mohoua* Lesson, 1837.
Megalestris	*Catharacta*, Brunnich, 1764.
Merganser	*Promergus* Mathews and Iredale, 1913.
Miro (part)	*Nesomiro* Mathews and Iredale, 1813.
Ninox	*Spiloglaux* Kaup, 1848.
Notornis	*Mantellornis* Mathews, 1911.
Ochthodromus (obscurus)	*Pluviorhynchus* Bonaparte, 1856.
,, *(bicinctus)*	*Cirrepidesmus* Bonaparte, 1856.
Ocydromus	*Gallirallus* Lafresnaye, 1841.
Oestrelata (part)	*Pterodroma* Bonaparte, 1856.
,, ,,	*Cookilaria* Bonaparte, 1856.
Ossifraga	*Macronectes* Richmond, 1906.
Petroeca	*Myiomoira* Reichenbach, 1850.
Phalacrocorax (part)†	*Carbo* Lacepède, 1799.
,, ,,	*Hypoleucus* Reichenbach, 1852.
,, ,,	*Stictocarbo* Bonaparte, 1855.
,, ,,	*Microcarbo* Bonaparte, 1856.
,, ,,	*Mesocarbo* Mathews and Iredale, 1913.
Podiceps (rufopectus)	*Poliocephalus* Selby, 1840.
Pogonornis	*Notiomystis* Richmond, 1908.
Prion	"*Prion* of Lacepède is indeterminable."
,, (part)	*Pachyptila* Illiger, 1811.
,, ,,	*Pseudoprion* Coues, 1866.
,, ,,	*Heteroprion* Mathews, 1912.
Porzana (tabuensis)	*Porzanoidea* Mathews, 1912.
Pseudogerygone (part)	*Maorigerygone* Mathews and Iredale, 1913.
,, ,,	*Hapolorhynchus* Reichenow, 1908.
Puffinus (gavia)	*Reinholdia* Mathews, 1912.
Sphenoeacus	*Bowdleria* Rothschild, 1896.
Sterna (nereis)	*Sternula* Boie, 1822.
Stringops	*Strigops* Gray, 1845.

* See p. 193. † But see p. 193.

In List II, of the purely native birds, I have arranged the birds in the order they have in the "Index Faunae Novae-Zealandiae," for that is a work that every naturalist in New Zealand ought to have by him; at any rate, it is one that he is more likely to have than Buller's large and expensive work. The authors of the "Reference List" follow the arrangement in

the Supplement to Buller's Birds, which is the latest and most complete list of the birds, native and visiting, that have been recorded in our area.*

In those cases where the species is not mentioned in the Index, but is in the Supplement, the word "(Suppl.)" is placed after the name.

Birds which are not to be found in either work, but which have either been unearthed from the literature by Mathews and Iredale or have been described since the publication of the Supplement, are enclosed in square brackets, thus: [ ].

A few new subspecific names are bestowed by the authors of the "Reference List"; these are indicated in the left-hand column by three asterisks, thus: * * *.

In the right-hand column I have given the names of the orders and families as adopted by recent ornithologists, which differ in some cases from those given in the Index. Comparison also with the Supplement is rendered easy.

The full name of the species and subspecies is followed by the name of the author of the latter. Almost every one of the species has been transferred by this time to some genus other than the one in which the author placed it, and according to the rules of nomenclature the author's name should be enclosed in brackets. These have been omitted. Then follows the breeding-place of the subspecies: if it breeds in both the North and South Islands no locality is mentioned; if it breeds only on one of the outlying islands these are mentioned; but in a few instances the breeding-place is unknown, or only doubtfully is it at the locality mentioned, when the question mark (?) is added, thus: "Breeds ? Snares Islands."

Any notes at the foot of the lists are either verbally taken or epitomized from the statements of Mathews and Iredale, unless initialled "W. B. B."

II.—LIST OF BIRDS WHICH BREED WITHIN THE NEW ZEALAND AREA.

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
	Order PASSERIFORMES.
	Fam. *Callaeidae.*
Glaucopis cinerea	*Callaeas cinerea* Gmelin. South Island.
G. wilsoni	*C. wilsoni* Bonaparte. North Island.
	Fam. *Neomorphidae.*
Heteralocha acutirostris	*Neomorpha acutirostris* Gould. North Island.
	Fam. *Creadiontidae.*
Creadion carunculatus	*Creadion carunculatus* Gmelin.
	Fam. *Turdidae.*
Turnagra crassirostris	*Turnagra capensis* Sparrman. South Island.
T. tanagra	*T. tanagra* Schlegel. North Island.
	Fam. *Bowdleriidae.*
Sphenoeacus punctatus	*Bowdleria punctata vealeae* Kemp. North Island.
S. fulvus	*B. punctata punctata* Quoy and Gaimard. South Island.
S. caudatus (Suppl.)	*B. punctata caudata* Buller. Snares Islands.
S. rufescens	*B. rufescens* Buller. Chatham Islands.

* By the New Zealand area is to be understood the two main islands (with Stewart Island), Chatham Islands to the east, and to the south the Snares, Auckland Islands, Campbell Islands, Antipodes Islands, Bounty Island, and Macquarie Islands. I have excluded the Kermadec Islands.

II.—List of Birds which breed within the New Zealand Area—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
	Fam. *Muscicapidae.*
Petroica toitoi	*Myiomoira toitoi* Lesson. North Island.
P. macrocephala	*M. macrocephala macrocephala* Gmelin. South Island.
[*P. dieffenbachii* Gray, 1843] ..	*M. macrocephala dieffenbachii* Gray. Chatham Islands.
Miro albifrons	*Miro australis australis* Sparrman. South Island.
M. bulleri (Suppl.)	*Miro australis bulleri* Buller. South Island; alpine.
M. australis (Suppl.)	*M. australis longipes* Lesson. North Island.
M. traversi	*Nesomiro traversi traversi* Buller. Chatham Islands.
M. dannefordi	*N. traversi dannefaerdi* Rothschild. Snares Islands.
Pseudogerygone igata	*Maorigerygone igata igata* Quoy and Gaimard. South Island.
P. sylvestris (Suppl.)	*M. igata sylvestris* Potts. South Island; alpine.
P. flaviventris	*M. igata flaviventris* Gray. North Island.
[*P. macleani* Grant, 1907] ..	*M. igata macleani* Grant. North Island mountains.
P. albofrontata	*Hapolorhynchus albofrontata* Gray. Chatham Islands.
Rhipidura flabellifera	*Rhipidura flabellifera flabellifera* Gmelin. South Island.
* * *	*R. flabellifera kempi* subsp. nov. North Island.
[*R. flabellifera penitus* Bangs, 1911]	*R. flabellifera penitus* Bangs. Chatham Islands.
R. fuliginosa	*R. fuliginosa* Sparrman. South Island.
	Fam. *Paridae.**
Certhiparus albicillus	*Certhiparus albicillus* Lesson. North Island.
C. novae-zealandiae	*Finschia novaeseelandiae* Gmelin. South Island.
Mahua ochrocephala	*Mohoua ochrocephala* Gmelin. South Island.
	Fam. *Meliphagidae.*
Pogonornis cincta	*Notiomystis cincta* Du Bus. North Island.
Anthornis melanura	*Anthornis melanura melanura* Sparrman. South Island.
[*Philedon dumerilii* Lesson, 1830]	*A. melanura dumerilii* Lesson (Voy. "Coquille"). North Island.
[*Anthornis incoronata* Bangs, 1911]	*A. melanura incoronata* Bangs. Auckland Islands.
A. melanocephala	*A. melanura melanocephala* Gray. Chatham Islands.
Prosthemadera novae-zealandiae (part)	*Prosthemadera novaeseelandiae novaeseelandiae* Gmelin. South Island.
[*P. novae-zealandiae phoebe* Kemp, 1912]	*P. novaeseelandiae phoebe* Kemp. North Island.
[*P. novae-zealandiae kwini* Kemp, 1912]	*P. novaeseelandiae kwini* Kemp. Auckland Islands.
	Fam. *Zosteropidae.*
Zosterops coerulescens	*Zosterops lateralis tasmanica* Mathews.
	Fam. *Motacillidae.*
Anthus novae-zealandiae (part) ..	*Anthus novaeseelandiae novaeseelandiae* Gmelin. South Island.
,, ,, ,,	*Anthus novaeseelandiae reischeki* Lorenz-Liburnau. North Island.
A. aucklandicus	*A. novaeseelandiae aucklandicus* Gray. Auckland Islands.
[*A. novae-zealandiae chathamensis* Lor.-Lib., 1902]	*A. novaeseelandiae chathamensis* Lorenz-Liburnau. Chatham Islands.
A. steindachneri	*A. novaeseelandiae steindachneri* Reischek. Antipodes Islands.

* See Hutton, *Ibis*, 1903, p. 31, whom the authors follow.

II.—LIST OF BIRDS WHICH BREED WITHIN THE NEW ZEALAND AREA—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
	Fam. *Acanthisittidae.*
Acanthidositta chloris	*Acanthisitta chloris chloris* Sparrman. South Island.
* * *	*A. chloris granti* subsp. nov. North Island.
	Fam. *Xenicidae.*
Xenicus longipes	*Xenicus longipes longipes* Gmelin. South Island.
X. stokesi (Suppl.)	*X. longipes stokesii* Gray. North Island.
X. gilviventris	*X. gilviventris* Pelzeln. South Island; alpine.
Traversia lyalli	*Traversia lyalli* Rothschild. Stephen Island. Extinct.
	Fam. *Alcedinidae.*
Halcyon vagans (part)	*Sauropatis sanctus vagans* Lesson. North Island.
" " "	*S. sanctus forsteri* subsp. nov. South Island.
	Order COCCYGES.
	Fam. *Cuculidae.*
Chalcoccyx lucidus	*Lamprococcyx lucidus* Gmelin. "Winter quarters still unknown."*
Urodynamis taitensis	*Urodynamis taitensis* Sparrman.
	Order STRIGIFORMES.
	Fam. *Bubonidae.*
Ninox novae-zealandiae (part) ..	*Spiloglaux novaeseelandiae novaeseelandiae* Gmelin. South Island.
[*N. venatica* Peale, 1848] ..	*S. novaeseelandiae venatica* Peale. North Island.
Sceloglaux albifacies	*Sceloglaux albifacies albifacies* Gray. South Island.
S. rufifacies (Suppl.)	*S. albifacies rufifacies* Buller. North Island.
	Order PSITTACIFORMES.
	Fam. *Nestoridae.*
Nestor notabilis	*Nestor notabilis* Gould. South Island.
N. meridionalis = *N. esslingi* (Suppl.)	*N. meridionalis meridionalis* Gmelin. South Island.
[*N. septentrionalis* Lorenz, 1896]	*N. meridionalis septentrionalis* Lorenz. North Island.
	Fam. *Cacatuidae.*
Cyanorhamphus unicolor ..	*Cyanorhamphus unicolor* Lear. Antipodes Island.
C. novae-zealandiae	*C. novaezelandiae novaezelandiae* Sparrman.
[*Platycercus hochstetteri* Reischek, 1889]	*C. novaezelandiae hochstetteri* Reischek. Antipodes Island.
Cyanorhamphus aucklandicus ..	*C. novaezelandiae aucklandicus* Reichenow. Auckland Islands.
C. erythrotis	*C. novaezelandiae erythrotis* Wagler. Macquarie Island.
C. auriceps	*C. auriceps auriceps* Kuhl. South Island.
* * *	*C. auriceps macleani* subsp. nov. North Island
C. forbesi	*C. auriceps forbesi* Rothschild. Chatham Islands.
C. malherbi	*C. mulherbi* Souancé. South of South Island.

* Mathews: "Austral Avian Record," vol. 1, 1912, p. 15.

II.—List of Birds which breed within the New Zealand Area—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
	Fam. *Strigopidae.*
Stringops habroptilus	*Strigops habroptilus habroptilus* Gray. South Island.
* * *	*S. habroptilus innominatus* subsp. nov.*
* * *	*S. habroptilus parsonsi* subsp. nov.†
	Order Accipitriformes.
	Fam. *Falconidae.*
Nesierax novae-zealandiae ..	*Nesierax novaeseelandiae* Gmelin. "Quail-hawk."
N. australis	*N. pottsi* sp. nov. "Bush-hawk."‡
Circus gouldi	*Circus approximans drummondi* subsp. nov.
	Order Galliformes.
	Fam. *Phasiandiae.*
Coturnix novae-zealandiae ..	*Coturnix novae-zealandiae* Quoy and Gaimard. Extinct.
	Order Columbiformes.
	Fam. *Treronidae.*
Hemiphaga novae-zealandiae ..	*Hemiphaga novaeseelandiae novaeseelandiae* Gmelin.
H. chathamensis	*H. novaeseelandiae chathamensis* Rothschild. Chatham Islands.
	Order Ralliformes.
	Fam. *Rallidae.*
Hypotaenidia philippensis ..	*Hypotaenidia philippensis assimilis* Gray.
H. macquariensis	*H. philippensis macquariensis* Hutton. Macquarie Island.
H. muelleri	*Rallus muelleri* Rothschild.
Nesolimnas dieffenbachii ..	*Nesolimnas dieffenbachii* Gray.
Cabalus modestus	*Cabalus modestus* Hutton.
Ocydromus australis = *O. earli* Gray	*Gallirallus australis australis* Sparrman. South Island.

* Buller (Birds N.Z., 1873, p. 23, footnote) states that the only specimen of the kakapo from the North Island is very small. The authors of the "Reference List" write: "We are adopting the extreme course, and naming the race. Inasmuch as the kakapo is flightless, there is every reason to suggest that the birds inhabiting the two Islands should constitute recognizable races."

† An extremely large form lives in the mountains of the north-west of the South Island, and they name it; but, as the authors note, Reischek maintains that of the large series of birds collected by him at Dusky Sound (at the south-west of the South Island) those living at the heights were larger and lighter than those at or near the sea-level.

‡ It may be noted that they adopt the view that there are two species of hawks; and, though they are unable to settle the question finally, they name the smaller form *N. pottsi*, which agrees precisely in colour with the larger. At the same time they express some doubt as to whether the small size is specific. It was necessary to choose a new name, for they found that *australis* o fHombron and Jacquinot is not synonymous with *australis* of Gmelin.

II.—LIST OF BIRDS WHICH BREED WITHIN THE NEW ZEALAND AREA—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds	Names as given in the "Reference List" of Mathews and Iredale
O. greyi (Suppl.)	*G. australis greyi* Buller. North Island.
[*O. scotti* Grant, 1905]	*G. australis scotti* Grant. Stewart Island.
O. hectori	*G. hectori* Hutton. South Island.*
O. brachypterus	*G. brachypterus* Lafresnaye. South-west coast of South Island.
Porzana affinis	*Porzana pusilla affinis* Gray.
P. tabuensis	*Porzanoidea plumbea plumbea* Gray.
Porphyrio melanonotus	*Porphyrio melanonotus stanleyi* Rowley.
P. chathamensis	*P. melanonotus chathamensis* Sharpe. Chatham Islands.
Notornis hochstetteri	*Mantellornis hochstetteri* Meyer.
	Order ARDEIFORMES.
	Fam. *Ardeidae.*
Herodias timoriensis	*Herodias alba maoriana* subsp. nov.
Notophoyx novae-hollandiae ..	*Notophoyx novaehollandiae* Latham.
Demiegretta sacra	*Demiegretta sacra matook* Vieillot.
Ardetta pusilla	*Ixobrychus minutus novaezelandiae* Potts.
Botaurus poeciloptilus	*Botaurus poeciloptilus melanotus* Gray.
	Order CHARADRIFORMES.
	Fam. *Haematopodidae.*
Haematopus longirostris	*Haematopus ostralegus finschi* Martens.
H. unicolor	*H. niger unicolor* Forster.
	Fam. *Charadriidae.*
Ochthodromus obscurus	*Pluviorhynchus obscurus* Gmelin.
O. bicinctus	*Cirrepidesmus bicinctus* Jardine and Selby.
Thinornis novae-zealandiae ..	*Thinornis novaeseelandiae* Gmelin.
T. rossi	Juvenile stage of preceding.†
Anarhyncus frontalis	*Anarhyncus frontalis* Quoy and Gaimard.
	Fam. *Recurvirostridae.*
Himantopus picatus‡	*Himantopus leucocephalus alba* Ellman.
H. melas	*H. novaezealandiae* Gould.
	Fam. *Scolopacidae.*
Limosa novae-zealandiae ..	*Limosa lapponica baueri* Naumann.
Gallinago aucklandica	*Coenocorypha aucklandica aucklandica* Gray. Auckland Islands.
G. huegeli	*C. aucklandica huegeli* Tristram. Snares Islands.
G. pusilla	*C. aucklandica pusilla* Buller. Chatham Islands.
[*G. tristrami* Rothschild, 1894] ..	*C. aucklandica tristrami* Rothschild. Antipodes Islands.

* "The common South Island woodhen must for the present bear the name of *G. hectori*." "It is obvious that we have not reached the truth as to the distribution and forms of the woodhen," owing to "the few specimens we have been able to examine."

† The authors suggest that the locality "Auckland Islands" in original description should read "Auckland."

‡ The authors place it in Witzsch's genus *Hypsibates*, with type *H. himantopus* Linné. According to my reading of the Report of International Committee, the name *Himantopus* must remain.—W. B. B.

II.—List of Birds which breed within the New Zealand Area—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
	Order Lariformes.
	Fam. *Laridae.*
Hydroprogne caspia	*Hydroprogne tschegrava oliveri* subsp. nov.
Sterna albistriata	*S. albistriata albistriata* Gray.
S. vittata	*S. vittata bollonsi* subsp. nov.
S. frontalis	*S. striata striata* Gmelin.
S. bethunei (Suppl.)	*S. striata bethunei* Buller. Auckland Islands.
S. nereis	*Sternula nereis davisae* subsp. nov.
Larus bulleri	*Bruchigavia melanorhyncha* Buller.
L. scopulinus	*B. novaehollandiae scopulinus* Forster.
L. dominicanus	*Larus dominicanus antipodus* Bruch.
Megalestris antarctica	*Catharacta lonnbergi lonnbergi* Mathews.
	Order Pelecaniformes.
	Fam. *Sulidae.*
Sula serrator	*Sula bassana serrator* Gray.
	Fam. *Carbonidae.*
*Phalacrocorax carbo**	*Phalacrocorax carbo steadi* subsp. nov.†
P. varius	*Hypoleucus varius varius* Gmelin.
P. chalconotus	*H. chalconotus* Gray. Stewart Island.
P. campbelli	*H. campbelli campbelli* Filhol. Campbell Islands.
P. colensoi	*H. campbelli colensoi* Buller. Auckland Islands.
P. stewarti	*H. campbelli stewarti* Grant. Stewart Island.
P. ranfurlyi	*H. campbelli ranfurlyi* Grant. Bounty Islands
P. carunculatus	*H. carunculatus carunculatus* Gmelin. North of the South Island.
P. onslowi	*H. carunculatus onslowi* Forbes. Chatham Islands.
P. traversi	*H. carunculatus traversi* Rothschild. Auckland Islands, Macquarie Island.
P. sulcirostris	*Mesocarbo ater purpuragula* Peale.
P. melanoleucus = *P. brevirostris* ..	*Microcarbo melanoleucos brevirostris* Gould.
P. punctatus	*Stictocarbo punctatus* Sparrman.
P. featherstoni	*S. featherstoni* Buller. Chatham Islands.
	Order Procellariiformes.
	Fam. *Hydrobatidae.*
Oceanites oceanicus	*Oceanites oceanicus exasperatus* Mathews. Cape Adare.
Garrodia nereis	*Garrodia nereis nereis* Gould.
Pelagodroma marina	*Pelagodroma marina maoriana* Mathews. Chatham Islands, Auckland Islands.
Cymodroma melanogaster ..	*Fregetta tropica melanogaster* Gould.
	Fam. *Procellariidae.*
Puffinus gavia (Suppl.)	*Reinholdia reinholdi reinholdi* Mathews.
[*P. reinholdi huttoni* Mathews, 1912]	*R. reinholdi huttoni* Mathews. Snares Islands.
P. bulleri	*Puffinus bulleri* Salvin. Breeds ? loc.
P. gavia Forster	*P. assimilis gavia* Forster.
[*P. assimilis kempi* Mathews, 1912]	*P. assimilis kempi* Mathews. Chatham Islands.

* Note extract above from the report of the International Committee on Bird-names. The name *Phalacrocorax* is to be retained for this species. The authors would replace it by *Carbo* Lacepède, 1799.—W. B. B.

† "*Carbo carbo steadi* [that is, *Phalacrocorax carbo steadi* (W. B. B.)] is easily separated from the typical *C. c. carbo* by the scant white neck-feathers of the summer plumage, as well as by size"; and the average measurements are given.

II.—LIST OF BIRDS WHICH BREED WITHIN THE NEW ZEALAND AREA—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
P. carneipes	*P. carneipes carbonarius* Mathews.
P. griseus	*P. griseus griseus* Gmelin.
Majaqueus aequinoctialis ..	*Procellaria aequinoctialis steadi* Mathews. Antipodes Islands, Auckland Islands.
M. parkinsoni	*P. parkinsoni* Gray.
Oestrelata macroptera	*Pterodroma macroptera gouldi* Hutton.
O. lessoni	*P. lessoni leucocephala* Forster. Antipodes Islands, Auckland Islands.
O. gularis	*P. inexpectata inexpectata* Forster.
O. cooki	*Cookilaria cookii cookii* Gray.
O. axillaris	*C. cookii axillaris* Salvin. Chatham Islands.
Ossifraga gigantea (part) ..	*Macronectes giganteus albus* Potts. Breeds ?
,, ,, ,, ..	*M. giganteus wilsoni* Mathews. ? Macquarie Island.
Daption capensis	*Daption capense* Linné. ? Snares Islands.
Prion vittatus	*Pachyptila vittatus vittatus* Gmelin.
P. banksi	*Heteroprion desolatus alter* Mathews. Auckland Islands.
[*Heteroprion desolatus macquariensis*, Mathews, 1912]	*H. desolatus macquariensis* Mathews. Macquarie Island.
Prion desolatus Gm. = *P. turtur* Buller *P. ariel* Gould = *P. brevirostris* Buller	*Pseudoprion turtur huttoni* Mathews. Chatham Islands.
[*Pseudoprion turtur crassirostris* Mathews, 1912]	*P. turtur crassirostris* Mathews. Bounty Islands.
	Fam. *Pelecanoididae.*
Pelecanoides urinatrix = *P. exsul*	*Pelecanoides urinatrix urinatrix* Gmelin.
	Fam. *Diomedeidae.*
Diomedea regia (part)	*Diomedea epomophora epomophora* Lesson. Campbell Islands.
,, ,, ,, ...	*D. epomophora maccormicki* Mathews. Enderby Island.
D. melanophrys	*Thalassarche melanophris impavida* Mathews. Campbell Islands.
D. bulleri	*T. bulleri* Rothschild. Snares Islands.
Thalassogeron salvini	*Thalassogeron cautus salvini* Rothschild. Bounty Islands.
T. culminatus	*T. chrysostoma mathewsi* Rothschild. Campbell Islands.
T. chlororhynchus	*T. chlororhynchus bassi* Mathews.
Phoebetria fuliginosa	*Phoebetria palpebrata huttoni* Mathews. Subantarctic islands.
	Order SPHENISCIFORMES.
	Fam. *Spheniscidae.*
Aptenodytes patagonica	*Aptenodytes patagonica halli* Matthews. Macquarie Island.
Pygoscelis papua	*Pygoscelis papua taeniata* Mathews. Macquarie Island.
Catarrhactes chrysocome ..	*Eudyptes chrysocome chrysocome* Forster. Antipodes Islands.
C. pachyrhynchus	*E. chrysocome pachyrhynchus* Gray. Snares Islands.
C. sclateri	*E. chrysocome sclateri* Buller. Auckland Islands.
[*Eudyptes filholi* Hutton, 1878] ..	*E. chrysocome filholi* Hutton. Campbell Islands.
Catarrhactes schlegeli	*E. schlegeli* Finsch. Macquarie Island.
Megadyptes antipodum	*Megadyptes antipodes* Hombron and Jacquinot. South Island.

II.—List of Birds which breed within the New Zealand Area—*continued.*

Names as given in the "Index Faunae Novae-Zealandiae" or in the Supplement to Buller's Birds.	Names as given in the "Reference List" of Mathews and Iredale.
Eudyptula minor	*Eudyptula minor minor* Forster. South Island.
E. albosignata	*E. minor albosignata* Finsch. Banks Peninsula.
[*E. minor iredalei* Mathews, 1911]	*E. minor iredalei* Mathews. Chatham Islands.
	Order Podicipiiformes.
	Fam. *Podicipiidae.*
Podiceps cristatus	*Podiceps cristatus australis* Gould.
P. rufipectus	*Poliocephalus rufopectus* Gray.
	Order Anseriformes.
	Fam. *Anatidae.*
Casarca variegata	*Casarca variegata* Gmelin.
Anas superciliosa	*Anas superciliosa superciliosa* Gmelin.
Nettion gibberifrons	"Unable to satisfy ourselves of the occurrence either in Australia or New Zealand."
Elasmonetta chlorotis	*Elasmonetta chlorotis* Gray.
Nesonetta aucklandica	*Nesonetta aucklandica* Gray. Auckland Islands.
Spatula rhynchotis	*Spatula rhynchotis variegata* Gould.
Fuligula novae-zealandiae ..	*Fuligula novaeseelandiae* Gmelin.
Hymenolaemus malacorhynchus ..	*Hymenolaimus malacorhynchos* Gmelin.
Merganser australis	*Promergus australis* Hombron and Jacquinot. Auckland Islands.
	Order Apterygiformes.
	Fam. *Apterygidae.*
Apteryx australis	*Apteryx australis australis* Shaw and Nodder. South Island.
A. lawryi (Suppl.)	*A. australis lawryi* Rothschild. Stewart Island.
A. mantelli	*A. australis mantelli* Bartlett. North Island.
A. oweni	*A. owenii owenii* Gould. ? Both Islands.
A. occidentalis	*A. owenii occidentalis* Rothschild. West Coast ranges, South Island.
A. haasti	*A. haastii* Potts. West Coast ranges, South Island.

List III.—Many of the birds included in the Index and the Supplement are not native to the country; they do not breed within the New Zealand area; they are occasional visitors, stragglers from neighbouring lands. In the Index no notification is given that many of these are not in the same category as our truly native forms; and though Hutton does give a list of wanderers, on page 37, yet he includes in the body of his list many of those enumerated below.

It is desirable that our list of birds be purged of these occasional visitors. I have excluded from this list the birds which occur on the Kermadec Islands, for on the evidence of most of the groups of the animal kingdom. these islands lie outside the New Zealand area, though in the case of the birds many of our natives do occur there; and Iredale has recently published a list of the birds of the Kermadecs (Trans. N.Z. Inst., vol. 45, 1913, p. 78).

In this list I have again followed the arrangement of the Index, and have added after the modern names of the birds the number of occurrences in New Zealand which have been recorded, and which have been verified by the authors of the list so far as possible. It will be seen on what slender justification many—indeed, most—of them have been included in lists of New Zealand birds.

III.—LIST OF EXTRA-LIMITAL SPECIES—THAT IS, WHICH BREED OUTSIDE THE NEW ZEALAND AREA, BUT OCCASIONALLY VISIT NEW ZEALAND, AND OF WHICH ONLY A FEW OCCURRENCES HAVE BEEN RECORDED.

Index or Supplement.	"Reference List."
	Order PASSERIFORMES.
	Fam. *Camphophagidae.*
Graucalus melanops	*Coracina robusta robusta* Latham. Three occurrences.
	Fam. *Meliphagidae.*
Acanthochaera carunculata ..	*Coleia carunculata* Latham. Twice.
	Fam. *Hirundinidae.*
Petrochelidon nigricans	*Hylochelidon nigricans nigricans* Vieillot. Few occurrences.
	Order COCCYGES.
	Fam. *Cuculidae.*
Cuculus saturatus (Suppl.) ..	*Cuculus optatus* Gould. Once.
	Order CORACIIFORMES.
	Fam. *Coraciidae.*
Eurystomus australis	*Eurystomus orientalis pacificus* Latham. Few.
	Fam. *Apodidae.*
Chaetura caudacuta	*Chaetura caudacuta caudacuta* Latham. Once.
Micropus pacificus	*Apus pacificus* Latham. Once.
	Order ACCIPITRIFORMES.
	Fam. *Falconidae.*
Cerchneis cenchroides	*Cerchneis cenchroides cenchroides* Vigors and Horsfield. Twice.
	Order RALLIFORMES.
	Fam. *Rallidae.*
Rallus featherstoni Buller (Essay Ornith. N.Z., 1865)	*Crex crex* Linné. Once.
Fulica australis	*Fulica tasmanica* Grant. Once.
	Order ARDEIFORMES.
	Fam. *Plataleidae.*
Platalea regia	*Platalea regia regia* Gould. Thrice.
	Fam. *Plegadidae.*
Plegadis falconellus	*Plegadis falconellus* Linné. Once.
	Fam. *Ardeidae.*
Ardea cinerea	*Ardea cinerea rectirostris* Gould. Once.
Nycticorax caledonicus	*Nycticorax caledonicus australasiae* Vieillot. Few occurrences.
	Order CHARADRIFORMES.
	Fam. *Morinellidae.*
Arenaria interpres	*Morinella interpres oahuensis* Bloxham. Irregular visitor.
	Fam. *Charadriidae.*
Lobivanellus lobatus	*Lobibyx novaehollandiae* Stephens. Once.
Charadrius dominicus	*Pluvialus dominicus fulvus* Gould. Irregular visitor.
Aegialitis ruficapilla	*Leucopolius ruficapillus ruficapillus* Temminck. Once.

III.—List of Extra-limital Species—*continued.*

Index or Supplement.	"Reference List."
	Fam. *Recurvirostridae.*
Recurvirostra novaehollandiae ..	*Recurvirostra novaehollandiae novaehollandiae* Vieillot. Few occurrences.
	Fam. *Scolopacidae.*
Limosa hudsonica	*Limosa limosa haemastica* Linné. Once.
Numenius cyanopus	*Numenius cyanopus* Vieillot. Few occurrences.
Mesoscolopax minutus	*Mesoscolopax minutus* Gould. Once.
Heteraclitis incanus	*Heteroscelus incanus* Gmelin. A pair.
Glottis nebularis	*Glottis nebularis* Gunner. Once.
Anchylochilus subarquatus (Suppl.)	*Erolia ferruginea* Brunnich. Few.
Limonites ruficollis	*Pisobia minuta ruficollis* Pallas. ? Once. "The record requires investigation."
Heteropyga acuminata	*Heteropyga maculata acuminata* Horsfield. Irregular visitor.
Tringa canutus	*Canutus canutus* Linné. Occasional visitor.
Gallinago australis	*Gallinago hardwickii* J. E. Gray. Once.
	Fam. *Phalaropidae.*
Crymophilus fulicarius	*Phalaropus fulicarius* Linné. Once.
Stiltia isabella	*Stiltia isabella* Vieillot. Once.
	Order Lariformes.
	Fam. *Laridae.*
Hydrochelidon leucoptera ..	*Hydrochelidon leucoptera grisea* Horsfield. Once.
Stercorarius crepidatus	*Stercorarius parasiticus* Linné. Accidental visitor.
Megalestris maccormicki (Suppl.)..	*Catharacta maccormicki maccormicki* Saunders. Once. Breeds on Victoria Land.
	Order Pelecaniformes.
	Fam. *Plotidae.*
Sula sula	*Sula leucogaster plotus* Forster. Twice.
Plotus novae-hollandiae ..	*Plotus novaehollandiae novaehollandiae* Gould. Once.
	Fam. *Fregatidae.*
Fregata aquila..	*Fregata aquila palmerstoni* Gould. Thrice.
F. ariel	*F. ariel ariel* Gould. Once.
	Fam. *Pelecanidae.*
Pelecanus conspicillatus.. ..	*Pelecanus conspicillatus conspicillatus* Temminck. Once.
	Order Procellariiformes.
	Fam. *Hydrobatidae.*
[*Thalassidroma lineata* Peale, 1848]	*Pealea lineata* Peale. Twice.
	Fam. *Procellariidae.*
Puffinus tenuirostris	*Puffinus tenuirostris brevicauda* Gould. "It is very doubtful whether this has occurred in New Zealand waters."
Priofinus cinerea	*Priofinus cinerea* Gmelin. Scarce; straggler.
Priocella glacialoides	*Priocella antarctica* Stephens. Scarce; straggler.
Thalassoeca antarctica	*Thalassoica antarctica* Gmelin. ? Once.
Halobaena coerulea	*Halobaena coerulea* Gmelin. Twice.
	Order Anseriformes.
	Fam. *Anatidae.*
Dendrocygna eytoni	*Dendrocygna eytoni munna* Mathews. Few occurrences.
Nettion castaneum	*Nettion castaneum* Eyton. Few.
Nyroca australis	*Nyroca australis* Few.

ART. XXVIII.—*Notes on the Birds of South-western Otago.*

By ALFRED PHILPOTT.

Communicated by Dr. W. B. Benham, F.R.S.

[*Read before the Otago Institute, 7th October, 1913.*]

FROM the 6th July, 1911, to the 11th May, 1912, I had the pleasure of conducting a weekly "Nature Column" in the *Southland Times*. During that time many interesting letters dealing with our native birds were sent in, and I have thought it advisable that where these contained new or little-known facts such should be placed on record. In addition, I have given a few observations of my own. To my many careful correspondents my best thanks are due, and I have also to express my indebtedness to the editor of the *Southland Times* for the opportunity afforded of getting into touch with other observers. The names used are those adopted by Hutton and Drummond in "The Animals of New Zealand."

SOUTH ISLAND CROW (*Glaucopis cinerea*).

Mr. E. Stocker writes, "In the wooded parts of the high country above Pegasus (Stewart Island) the native crow is still plentiful and very tame, that part of the country being pretty well left to the native fauna." This interesting bird is also to be found in the bush-covered coastal ranges west of the Waiau River, and probably has a secure and permanent home throughout the suitable portions of the National Park.

GREY WARBLER (*Pseudogerygone igata*).

The grey warbler is one of the most common of the smaller bush-birds. It does not seem to be in any danger of extinction, the smallest patch of bush almost always sheltering a pair or two. It also visits orchards, gardens, plantations, and hedges.

SOUTH ISLAND ROBIN (*Miro albifrons*).

Up to eleven or twelve years ago robins were common enough in the bush round Invercargill. In September, 1901, I found a nest containing two newly hatched young birds. It was built in a sapling some 12 ft. or 14 ft. from the ground. The parent bird left the nest and fluttered anxiously round almost within arm's length. On being offered a small worm in the palm of the hand, she, after a little hesitation, seized and swallowed it. Since about that time the bird seems to have disappeared from the neighbourhood of Invercargill.

The robin still holds out in some parts of Southland.. Mr. Jules H. Tapper, writing on the 20th July, 1911, says that a few are still to be found in the bush near Clifden, though he says, "I am sorry to say that the robins hereabouts are the only specimens that I have met with on this side of the Waiau River. It is only a few months ago that I went from the bottom to the top of Lake Hauroko without seeing any traces of them, and six months ago

I was on the Preservation Inlet track, with similar results." With regard to the latter localities, the writer, in March, 1911, travelled through the bush from the Waiau to the inlet and back and has also since then twice traversed the bush between the sea-coast and the southern end of Hauroko without seeing any signs of the robin. Messrs. Crosby Smith and Gibb, however, visiting the lake in 1910, found a few robins there, so that it appears that the bird disappeared from the environs of the lake at quite a recent date.

From other correspondents I learn that the robin is still to be found at Grove Bush, Caroline, The Longwoods, Spar Bush, Kapuka, and Stewart Island. In none of these places, however, is the bird common, and it is therefore pleasing to hear from Mr. R. Gibb that at Waikaia the species is still plentiful. Writing under date of 12th March, 1912, Mr. Gibb says, "Last Saturday I had a trip to the Waikaia Bush, and found the robin the commonest bird there. Altogether I must have seen twenty in the space of three or four hours. Their song, too, was to be heard in every gully. Unfortunately, this bush had been badly burned about three years ago. The robins were right out on the edge of the birch forest, and even came and perched on the stumps and fallen trees in the cleared glades."

From Mr. Jules Tapper comes an observation that I think is new in the life-history of the robin. I quote from a letter of the 20th July, 1911: "A short time ago I was witness of a rather unique and pretty spectacle enacted by a couple of robins. One of the birds—presumably the female—was perched on a rotten stump about a foot from the ground, whilst its mate, with wings extended, was executing a series of movements for all the world like certain figures in the skirt-dance." As far as I am aware, the love-dance of the robin at pairing-time has never before been recorded. It is well known that the males of different birds indulge in certain fantastic posturings with the apparent object of gaining the good will of the hen birds. The argus pheasant and several of the same family, the North American grouse, the blackcock, various humming-birds, snipe, and ruff are cases in point. But these are all, or nearly all, instances in which the male bird is considerably more ornamented than the female. In the case of the robin there is little apparent difference between the sexes, and it is the more interesting to find that in so homely a bird courting posturings have been developed.

The explanation usually given to account for the disappearance of the robins is that stoats and weasels have been the agents of extermination. While it is undoubted that these vermin are the most bitter foes of many of our native birds, there are circumstances in the case of the robin which tend to modify such a conclusion. From Mr. A. W. Traill I learn that, though stoats and weasels have not yet made their appearance in Stewart Island, the robin is now only to be found far back in the bush, out of reach of settlement.

Mr. Gibb suggests that the main cause of the scarcity of the robin is to be sought in diseases introduced by imported birds.

Fantails (*Rhipidura*).

So many instances of the interbreeding of *R. flabellifera* and *R. fuliginosa* have come under my notice that I am inclined to doubt the advisability of regarding the two forms as distinct species. In February, 1897, I came on a black fantail feeding its young. Two of the three young birds were black, and the remaining one pied. The other parent did not put in

an appearance. In November, 1910, a group of four young birds—three pied and one black—was observed. They were being fed by both old birds, one of which was pied and the other black. In the following February another family was found in the same locality, possibly a second brood of the former birds. In this instance also there were four young birds, but the varieties were equally divided. Only one parent was in attendance, and it was a black one. In December, 1911, another mixed brood was met with. Both parents were present, one black and the other pied, and of the young birds two out of the three were pied. During the summers of 1910–11 and 1911–12 I noticed three broods in which both old and young birds belonged to the pied form. At date of writing (6th August, 1913) a nest has been commenced by a black and pied pair, both birds taking part in its construction. In eight or nine days after leaving the nest the young birds begin to catch a few insects, and in the course of another week they are able to forage entirely for themselves.

TAWNY FERN-BIRD (*Sphenoeacus fulvus*).

The fern-bird is becoming very rare in Southland, but is still to be found in some of the more extensive swamps.

BROWN CREEPER (*Finschia novae-zealandiae*).

The brown creeper is still common where there are fairly extensive tracts of bush, but near cultivated districts it is not so often seen as formerly. I have several times come across the old birds feeding their young early in February, so it is probable that they rear at least two broods in the year.

BELL-BIRD (*Anthornis melanura*).

The bell-bird is quite common in the neighbourhood of Invercargill; in fact, its numbers seem to be increasing. It can be found in almost every plantation, and in the season of fruit-tree blossom it visits gardens in the heart of the town.

On the 18th October a nest was found containing three newly hatched young ones. It was about 10 ft. from the ground, and was well concealed under some dead hanging fronds of a tree-fern (*Dicksonia fibrosa*). The parents brought insects—chiefly *Tipulidae*, I think—every few minutes. If one parent was in the nest when the other approached, the latter gave a kind of low clucking call, which was at once answered, and was followed by the sitting bird leaving the nest. The female attacked me vigorously if I stood too near the nest, snapping her beak and buffeting me on the head and back. The male did not take much notice of my presence, nor did he give much help in feeding the young after the first few days. The hen bird is very careful to keep the nest clean, picking up and swallowing the smallest particle of excrement which falls within it, and pushing the nestlings from side to side in her search. When much alarmed she flies about near the nest with drooping wings, her fighting attitude, like that of many other birds. From this wing-drooping posture the tactics of feigned helplessness and broken wings have probably been evolved. I noticed no trace of the latter on the bell-bird's part; but her nest is quite hidden from view, so that such methods would have little value.

Though fed at first on a purely insect diet, the young birds soon learn to probe the fuchsia-flowers for honey, and they may often be observed

helping themselves to the nectar, while every now and then the parent appears with a supply of insects. Early in December the bush is full of young bell-birds learning to sing, their first efforts falling far short of perfection.

Rifleman (*Acanthidositta chloris*).

The rifleman is still plentiful in most Southland bushes. I have found the nest on several occasions, and it was always situated in the hollow of a tree, within a few feet of the ground, the entrance being so small that a finger could hardly be introduced.

Parrakeets (*Cyanorhamphus*).

Parrakeets are getting very scarce in the south. It has been suggested that the starling has interfered with their nesting habits by appropriating almost every hollow tree; but, though this may have been the case in those localities where the starling is plentiful, it does not account for the diminishing numbers of the parrakeet in extensive wooded districts where the starling does not occur.

I once found a nest of the yellow-fronted parrakeet (*C. auriceps*), containing five young birds, on the 22nd July.

Kakapo (*Stringops habroptilus*).

In the elevated country lying between Lake Hakapoua and the Kiwi Burn the kakapo is not uncommon. Near the coastal mining claims the bird is not now to be found, having been killed out by the miners' dogs.

Bush-hawk (*Nesierax australis*).

Mr. Jules Tapper furnishes some interesting notes on the hunting habits of the bush- or sparrow-hawk: "A short time ago I witnessed the killing of a skylark by a sparrow-hawk. The skylark took wing and began ascending in its usual manner, giving forth its glorious song. After it had reached a good height a sparrow-hawk came on the scene, and in circles also began ascending. When the lark noticed its enemy it stopped singing, but still continued its upward flight, with the sparrow-hawk in its wake. At last the skylark saw its chance, and took a sudden headlong dive, but the hawk, with a quicker movement, struck it, raising a small cloud of feathers, and, alighting in a patch of tussock, commenced its dinner."

The sparrow-hawk displays a deal of cunning when on the hunt. I was on one occasion driving in a gig, and at a certain spot was surprised to notice a sparrow-hawk flying low close behind. This position it kept up for a hundred yards or so, when it shot forward and caught a sparrow, which with others had been feeding in the middle of the road, before it could reach the shelter of the gorse hedge which grew alongside.

Wekas (*Ocydromus*).

Thirty years ago the weka was quite common in the neighbourhood of Invercargill, but now, as far as Southland is concerned, it is almost extinct. It is, I think, probable that sawmilling operations have had a large share in the extermination of the weka. The curiosity and pilfering habits of the bird led it to frequent the camps of the bushmen, and the bushman's dog found it an easy quarry. Poisoned grain laid for rabbits would also, no doubt, prove a deadly factor; but the weka had disappeared from some

districts before poisoned grain was introduced. The stoat and weasel, by robbing the nests and killing the young birds, probably aided only in a work of destruction already far advanced.

Mr. E. Stocker informs me that the weka is still fairly common in some parts of Stewart Island, but I am not sure whether *O. earli* or *O. australis* is referred to. From Mr. R. Gibb I learn that in 1889 he made a trip round Lake Hauroko without seeing or hearing a weka. In 1910 he again visited the locality and found the weka very common, in spite of the fact that stoats and weasels were then numerous. During the present year (1912), however, the weka, according to Mr. Jules Tapper, has again disappeared from the lake. These facts are interesting, and would appear to point to migratory habits on the part of the bird. Unfortunately, specimens were not secured, and it is uncertain whether the species may have been *O. australis* or the West Coast weka, *O. brachypterus*. The latter is quite common throughout the West Coast region, being particularly plentiful about Lake Hakapoua.

PUKEKO (*Porphyrio melanonotus*).

Once, when walking along the bank of a small creek, I came suddenly on a pukeko. It had been making a meal of fresh-water mussels. One shell had evidently been wrenched open but a few moments before my arrival, fragments of the mollusc still adhering to it. About half a dozen closed shells were lying about, two or three of which showed marks of the bird's attempts to open them. Many empty shells were scattered around.

WHITE HERON (*Herodias timoriensis*).

Though generally regarded as extinct in the south, I learn from Mr. E. Stocker that in 1910 two were known to frequent a certain locality in Stewart Island.

BLUE HERON (*Demiegretta sacra*).

The sea-stacks and rocky islets on the coast of Fiordland are favourite haunts for the blue heron. Mr. John Gray informs me that this birds breeds on some of the inshore islets, usually in inaccessible places.

BANDED DOTTEREL (*Ochthodromus bicinctus*).

It seems probable that this quaint little bird migrates from the south during the winter months. Mr. E. Stocker writes, "I may say that they pass over this town (Invercargill), as a rule at night, in the late autumn in large numbers. They seem invariably to select a break of still, drizzly weather for their flight, and for some years past I have heard their unmistakable 'chip, chip,' like the sound of two stones being sharply tapped together, passing overhead at no great height. I have also seen them on the foreshore of our estuary during the day at the same time of the year, usually in ones or twos, as though separated from the flock." Early in August the dotterel is again present, and in some seasons it returns in mid-July.

PIED STILT (*Himantopus picatus*).

Mr. Robert Gibb states that the pied stilt is not uncommon along the river-bed in the Waikaia Valley. It is also to be met with in fair numbers on the gravel beaches of the Mataura River, and Mr. Gibb thinks that the bird is certainly holding its own, if not becoming more numerous.

Southern Skua (*Megalestris antarctica*).

An interesting account of the predatory habits of the skua gull comes from Mr. A. W. Traill, of Stewart Island. He writes, "When passing along one of our ocean-beaches lately I heard the terrified screech of a kaka overhead, and found that the bird was being vigorously attacked by a skua gull, the kaka replying to its enemy's swoops by throwing itself on its back and presenting beak and claws, but making very poor fighting, though it succeeded in gaining the edge of the bush and darting into safety. It is not the first time I have noticed the same thing occur. Some years ago, when kakas happened to be very plentiful, and also very fat, a constant stream of these birds kept flying to and from one of our outlying islands, and quite a number of skuas had collected *en route*, and again and again I saw them strike at the unfortunate kakas, trying, apparently, to drive them into the sea. I never actually observed them succeed in doing this, but some fishermen, whose boats were lying near the island, assured me that they were often successful, and might be seen feeding on the bodies of their victims. I have seen the skua swoop down on a black-backed gull which had just obtained a choice prize in the fish line, and the gull would drop its catch and make off without any show of resistance. I do not think that the skua ever goes far inland, and, if so, this is fortunate, as on the Ruapuke Island headlands it has been found terribly destructive to young lambs."

When rambling over some hilltops near Preservation Inlet last year, our party noticed many skeletons of small sea-birds—petrels and suchlike. We were puzzled to account for their presence there, but thought that they were possibly the remains of birds which had come inland to breed and had fallen victims to the harrier. Later, when we reported the matter to Mr. S. P. Seymour, the veteran naturalist of the inlet, he at once told us that it was the work of the skua gull, which pounced on these small sea-birds and carried them inland to devour.

White-fronted Tern (*Sterna frontalis*).

This species is plentiful all round the coast, and at certain rocky points is to be seen in thousands. Mr. Jules Tapper writes of this bird, "They breed in large numbers on the gravelly reaches and islands in the Waiau River. I have seen their nests so plentiful that I have had to watch my footsteps in case I trampled upon them. About Christmas-time the parent terns are to be seen returning from the coast, each with a fish in its beak for its young. In February and March they migrate to the coast, and congregate in large numbers."

Black-backed Gull (*Larus dominicanus*).

There seems to be no doubt that the common gull does considerable damage at certain seasons on sheep-farms. Mr. James Miller, writing from Clifden, says, "I have requently known gulls to destroy both sheep and lambs. I do not mean that, like the kea, gulls will attack sheep running at large, but at the time when sheep are in full wool they are liable to become 'cast'—that is, they roll down an incline or lie with their backs in a slight hollow, and their bulky fleeces prevent them from rising. The gull starts opera ions on these helpless sheep by tearing out one or both of the eyes, scooping out the socket, and working its beak as far as possible into the brain-matter behind. In one or two cases I have found a cast sheep

with a gull hard at work, one eye being already out, and the sheep has recovered; but usually, if the sheep is found alive, it will be so weak from loss of blood that all one can do is to put it out of pain and save the skin. About three months ago, on a very rough morning, from my bedroom-window I saw a ewe trying to drive off two gulls from her lamb, which appeared to have been just dropped and to be too weakly to take to its legs. When one gull would approach the lamb the ewe would try to butt the marauder and chase it away for a dozen yards or so, the gull avoiding the sheep with the greatest ease. As soon as the sheep's attention was taken up with one gull the other would make a dive for the lamb, so that when the poor mother turned from the pursuit of the first enemy it was only to find the second attempting to devour her lamb. The same manœuvre was repeated, the first returning to the lamb while the ewe was driving off the second one. I hastily dressed, picked up my gun, and went to the rescue, but was too late to save the lamb, which I found to have one eye out and to be bleeding profusely. Here in Clifden I have never known a gull to attack a living rabbit, even in a trap, but in another part of Southland I have repeatedly seen them do so. This could be most readily seen after a wet stormy night, when the trappers do not trouble to go round their traps till the storm abates. Both gulls and hawks could then be seen fighting over and devouring the few unfortunate rabbits while they were still alive."

Mr. W. Philpott, of Moa Flat, also bears witness against the gull. He writes, "*Re* seagulls attacking sheep, I have seen them more than once pecking at sheep's eyes In every case the sheep was unable to get on its legs, being 'cast.' I remember once seeing a gull pecking at a sheep's head, and when the sheep struggled the gull would run back a little, but as soon as it was quiet it would come up again. One morning, about four years ago, when I went to look through the ewes I found that one had lambed and could not get up, and, it being a cold morning, the lamb was nearly perished. There were two or three gulls round it pecking at it, and before I got there they had pulled its tongue out and torn it off close to the root, so that I had to kill it. I have never seen gulls attack chickens or rabbits in traps."

In support of my correspondents, I am able to say that I once saw what looked like a predatory act on the part of a gull. Some gulls had gathered to a ploughed field, and a starling that approached was set upon and chased by one of the gulls. The small bird was evidently terrified, and was followed in all its twistings and turnings for some little time. A trustworthy observer told me that he once saw a gull pick up one of a brood of young turkeys, and, carrying it to a post, proceed to make a meal of it.

Mr. A. W. Traill, of Stewart Island, gives some interesting particulars of the gull's nesting habits: "Two seasons ago, in early spring, I spent a week or more busy in my boatshed. It was calm weather, and a pair of seagulls spent each day either sitting on a rock or swimming in the still water. For hours they would sit perfectly still side by side, occasionally conversing (I can use no other word) in a low muttering or warbling note. This love-song, which is seldom heard, is very interesting, and so unlike their usual harsh or wailing cry that it is difficult to realize that it is produced by the same bird. The black-backed seagull builds in the latter part of November, but on one occasion I found a gull sitting on eggs in February, so they may occasionally rear two broods. The parent birds are very solicitous over their young—any coasting harrier that appears in the

vicinity is speedily driven far afield; and, though the young soon leave the nest, both parents watch over them and feed them until they are as big as themselves—in fact, I believe the family keep together for nearly a full year." Mr. Traill also states that a gull kept in a garden for the purpose of keeping down slugs turned its attention to a vegetable diet, and disposed of its owner's tomatoes as fast as they came to maturity. Though having kept sheep for years, he has never known the gull to do any damage. He has, however, caught the weka in the act of picking out the eyes of a living sheep. Probably the ordinary food of the gull is so plentiful on the island that the sheep is unmolested.

Though often rearing its young near the seashore, the black-backed gull sometimes nests far inland. Mr. F. S. Oliver states that he found several nests containing half-fledged young birds on a mountain-side near Macetown, Wakatipu, at an elevation of over 5,000 ft. above sea-level. Mr. A. Tapper gives an instance of a river location being chosen as a breeding-ground. He writes, "On the Waiau, both above and below Clifden, there used to be two large colonies, which I have frequently visited during the nesting season. The island at the mouth of the Lillburn was approximately two acres in extent, and would have from a hundred to a hundred and fifty nests on it. Two eggs would be the average number, often one, sometimes three, seldom four. Of course, the nests with only one may not have had their full complement. The nests were raised on a kind of mound consisting of sand and white tussock, and I noticed that some were double the height of the others. Now, the question is whether the higher mounds were older nests that had been added to year after year, and the others of a later date—perhaps younger birds. It looked to me as if the old birds, with a little renovation—top-dressing, as it were—used the same nests year after year, as there were practically no old unused nests, as far as I can remember."

Crested Grebe (*Podiceps cristatus*).

This bird is still to be found on Lake Hauroko and other retired waters to the westward.

Little Grebe (*Podiceps rufipectus*).

Mr. Jules Tapper reports the little grebe as not uncommon on Lake Hauroko, and it probably frequents all the lakes and lagoons between Hauroko and the west coast.

Southern Kiwi (*Apteryx australis*).

Writing under date of the 17th September, 1911, Mr. E. Stocker says, "The big kiwi is still to be found there [the back country of Stewart Island] in plenty. A shy bird, and only coming out at night from its hiding-place in dark clumps of scrub or hollow trees, it is somewhat difficult of observation; but if one waits for a moonlight night and follows up the weird raspy note, usually to the edge of some stream or bog, there the bird may be seen driving his long bill into the soft ooze in search of insects which live below the surface, and which with worms, form its diet."

ART. XXIX.—*Classified List of the New Zealand* Rotatoria, *including Twelve Species not previously recorded.*

By C. BARHAM MORRIS, F.R.M.S.

[*Read before the Otago Institute, 7th October, 1913.*]

THE nomenclature in the following list is that adopted in Harring's "Synopsis of the *Rotatoria*," Bulletin 81, Smithsonian Institution, United States National Museum, and is in agreement with the International Code.

In cases where the names differ from those previously given when reporting the occurrence of the species in this country, both names are inserted to avoid confusion, together with the name of the writer, habitat, volume and page of the work in which the record is made.

A query is placed against those species which cannot be definitely identified on the information at present available.

I regret being prevented from doing much field-work during the past twelve months, and wish to record my great indebtedness to Mr. A. Cunningham, of Oamaru, for his assistance in pond-searching. No less than nine of the species here recorded for the first time from New Zealand were found by him.

Two new and interesting species—a *Brachionus* and a *Synchaeta*—have been sent Home to Mr. Rousselet for further examination and report.

The total number of species dealt with in this paper is seventy-six, out of which the doubtfuls number nine.

Order PLOIMA.

Fam. NOTOMMATIDAE.

Subfam. NOTOMMATINAE.

Genus **Notommata** Ehrenberg.

1. *N. aurita* (Müller). Pond near Oamaru. Not previously recorded in New Zealand.
2. *N. najas* Ehrenberg. Pond, Awamoa. Not previously recorded in New Zealand.
3. *N. saccigera* Ehrenberg. Pond, Weston, North Otago. Not previously recorded in New Zealand.
4. *N. tripus* Ehrenberg. Lily-pond, Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.
5. ? *N. pentophthalma* Hilgendorf. Pond, Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 116.

? Genus **Planoventer** Hilgendorf.

1. ? *P. varicolor* Hilgendorf. Pond, Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 118.

Genus **Proales** Gosse.

1. *P. decipiens* (Ehrenberg). Near Lincoln. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.

Genus **Diaschiza** Gosse.

1. *D. auriculata* (Müller).
   ? *D. taurocephalus* Hilgendorf. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 123.
2. *D. forficata* (Ehrenberg).
   D. paeta Gosse. Waihola Lake. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.
   Furcularia caeca Gosse. Maheno. Morris, Trans. N.Z. Inst., vol. 45, p. 166.
3. *D. globata* Gosse. Not previously recorded in New Zealand.
4. *D. gibba* (Ehrenberg).
   D. semiaperta Gosse. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 124.
5. *D. tenuior* Gosse. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.
6. *D. ventripes* Dixon-Nuttall. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.

Subfam. Dicranophorinae.

Genus **Dicranophorus** Nitzsch.

1. *D. auritus* (Ehrenberg).
   Eosphora aurita Werneck. Taieri Ferry. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.
2. *D. forcipatus* (Müller).
   Diglena forcipata Ehrenberg. Near Lincoln. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.

Fam. Epiphanidae.

Genus **Epiphanes** Ehrenberg.

1. *E. brachionus* (Ehrenberg).
   Notops brachionus Hudson. Dunedin: Woodhaugh Gardens. Morris, Trans. N.Z Inst., vol. 45, p. 165.
2. *E. senta* (Müller).
   Hydatina senta Ehrenberg. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.

Genus **Rhinoglena** Ehrenberg.

1. *R. frontalis* Ehrenberg.
   Rhinops vitrea Hudson. Weston. Morris, Trans. N.Z. Inst., vol. 45, p. 165.

Fam. Brachionidae.

Genus **Brachionus** Pallas.

1. *B. angularis* Gosse. Enfield. Morris, Trans. N.Z. Inst., vol. 45, p. 166.
2. *B. calyciflorus* Pallas.
   B. pala Ehrenberg. Oamaru. Morris Trans. N.Z. Inst., vol. 45, p. 166.
3. *B. capsuliflorus* Pallas.
   B. variabilis Hempel. Totara. Morris, Trans. N.Z. Inst., vol. 45, p. 167.
   B. bakeri Müller. Richmond's Crossing, North Otago. Morris, Trans. N.Z. Inst., vol. 45, p. 166.

4. *B. leydigii* Cohn.
   B. quadratus Rousselet. Palmerston South. Morris, Trans. N.Z. Inst., vol. 45, p. 167.
5. *B. urceus* (Linnaeus). Oamaru. Not previously recorded in New Zealand.

Genus **Keratella** Bory de St. Vincent.

1. *K. cochlearis* (Gosse).
   Anuraea cochlearis Gosse. Evansdale and Oamaru. Morris, Trans. N.Z. Inst., vol. 45, p. 167.
2. *K. quadrata* (Müller).
   Anuraea aculeata Ehrenberg. Oamaru. Morris, Trans. N.Z. Inst., vol. 45, p. 167.

Genus **Notholca** Gosse.

1. *N. striata* (Müller).
   N. jugosa Gosse. Lincoln. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.
   N. regularis Hilgendorf. Akatore Creek. Hilgendorf, Trans. N.Z. Inst. vol. 31, p. 132.

Genus **Anuraeopsis** Lauterborn.

1. *A. fissa* (Gosse).
   Anuraea hypelasma Gosse. Auckland. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.

Fam. Euchlanidae.

Genus **Euchlanis** Ehrenberg.

1. *E. dilatata* Ehrenberg. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.
2. *E. lyra* Hudson. Geraldine. Not previously recorded in New Zealand.

Genus **Lecane** Nitzsch.

1. ? *L. hudsoni* (Lord).
   Cathypna hudsoni Lord. Mount Eden, Auckland. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.
2. *L. luna* (Müller). Oamaru. Not previously recorded in New Zealand.

Genus **Monostyla** Ehrenberg.

1. *M. bulla* Gosse. Oamaru. Not previously recorded in New Zealand.
2. *M. cornuta* (Müller). Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.
3. *M. lunaris* (Ehrenberg). Waihola Lake. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.

Fam. Lepadellidae.

Genus **Lepadella** Bory de St. Vincent.

1. *L. acuminata* (Ehrenberg).
   Metopidia acuminata Ehrenberg. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 129.
2. *L. ovalis* (Müller).
   Metopidia solidus Gosse. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 130.

3. *L. rhomboides* (Gosse). Oamaru. Not previously recorded in New Zealand.
4. *L. salpina* Ehrenberg. Weston. Not previously recorded in New Zealand.
5. *L. triptera* Ehrenberg.
   Metopidia triptera Ehrenberg. Lincoln. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.

Genus Colurella Bory de St. Vincent.

1. *C. colurus* (Ehrenberg).
   Colurus amblytelus Gosse. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.

Fam. Trichotriidae.

Genus Trichotria Bory de St. Vincent.

1. *T. tetractis* (Ehrenberg).
   ? *Dinocharis inornata* Hilgendorf. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 121.
   Dinocharis tetractis Ehrenberg. Swamp, Waitaki River. Morris, Trans. N.Z. Inst., vol. 45, p. 166.

Fam. Trichocercidae.

Genus Trichocerca Lamarck.

1. *T. longiseta* (Schrank).
   Rattulus longiseta Jennings. North Otago. Morris, Trans. N.Z. Inst., vol. 45, p. 166.
2. *T. lophoessa* (Gosse).
   Mastigocerca lophoessa Gosse. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.
3. *T. rattus* (Müller).
   Rattulus rattus Jennings. Pukerau, near Waipahi. Morris, Trans. N.Z. Inst., vol. 45, p. 166.
4. *T. cimolius* (Gosse).
   ? *Rattulus cimolius* Gosse. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.

Genus Diurella Bory de St. Vincent.

1. *D. brachyura* (Gosse).
   Coelopus brachyurus Gosse. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.
2. *D. tenuior* (Gosse).
   Coelopus tenuior Gosse. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 270.
3. *D. tigris* (Müller).
   Rattulus tigeris Gosse. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.
4. *D. weberi* Jennings.
   Coelopus weberi Hilgendorf. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.

Fam. GASTROPODIDAE.

Genus **Gastropus** Imhof.

1. *G. minor* (Rousselet).
   Notops minor Rousselet. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 269.

Fam. SYNCHAETIDAE.

Genus **Synchaeta** Ehrenberg.

1. *S. pectinata* Ehrenberg. Balruddery, North Otago. Morris, Trans. N.Z. Inst., vol. 45, p. 165.
2. *S. tremula* (Müller). Garden-ponds, Oamaru. Not previously recorded in New Zealand.
3. *S. triophthalma* Lauterborn. Oamaru Harbour. Not previously recorded in New Zealand.

Fam. POLYARTHRIDAE.

Genus **Polyarthra** Ehrenberg.

1. *P. trigla* Ehrenberg.
   P. platyptera Ehrenberg. Oamaru. Morris, Trans. N.Z. Inst., vol. 45, p. 165.

Genus **Filinia*** Bory de St. Vincent.

1. *F. longiseta* (Ehrenberg).
   Triarthra longiseta Ehrenberg. North Otago. Morris, Trans. N.Z. Inst., vol. 45, p. 165.
2. *F. passa* (Müller).
   Triarthra mystacina Ehrenberg. North Otago. Morris, Trans. N.Z. Inst., vol. 45, p. 165.

Fam. ASPLANCHNIDAE.

Genus **Asplanchna** Gosse.

1. *A. brightwellii* Gosse. North Otago and South Canterbury. Morris, Trans. N.Z. Inst., vol. 45, p. 165.

Genus **Asplanchnopus** de Guerne.

1. *A. multiceps* (Schrank).
   A. myrmeleo Hudson. North Otago. Morris, Trans. N.Z. Inst., vol. 45, p. 165.

Fam. TESTUDINELLIDAE.

Genus **Testudinella** Bory de St. Vincent.

1. *T. patina* (Hermann).
   Pterodina patina Ehrenberg. Lincoln and Lake Waihola. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 271.

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* As this genus has been omitted from the classification table in the synopsis, I have inserted it here.

Order FLOSCULARIACEA.

Fam. Floscularidae.

Genus **Floscularia** Cuvier.

1. *F. ringens* (Linnaeus).
   Melicerta ringens Schrank. Petane Valley, Napier. Hamilton, Trans. N.Z. Inst., vol. 12, p. 301.

Genus **Limnias** Schrank.

1. *L. ceratophylli* Schrank. Ardgowan, Oamaru. Morris, Trans. N.Z. Inst., vol. 45, p. 164.

Genus **Ptygura** Ehrenberg.

1. *P. socialis* (Weber).
   Oecistes socialis Weber. Ardgowan. Morris, Trans. N.Z. Inst., vol. 45, p. 164.

Fam. Conochilidae.

Genus **Conochilus** Ehrenberg.

1. *C. hippocrepis* (Schrank).
   C. volvox Ehrenberg. Waikakahi. Morris, Trans. N.Z. Inst., vol. 45, p. 164.

Order COLLOTHECACEA.

Fam. Collothecidae.

Genus **Collotheca** Harring.

1. *C. ambigua* (Hudson).
   Floscularia ambigua Hudson. Mount Eden, Auckland. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 267.
2. *C. coronetta* (Cubitt).
   Floscularia coronetta Cubitt. The Hutt, Wellington. Stock, Trans. N.Z. Inst., vol. 25, p. 193.
3. *C. ornata* (Ehrenberg).
   Floscularia ornata Ehrenberg. Lincoln. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 267.

Order BDELLOIDA.

Fam. Philodinidae.

Subfam. Philodininae.

Genus **Philodina** Ehrenberg

1. *P. erythrophthalma* Ehrenberg. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.
2. *P. megalotrocha* Ehrenberg. Mount Eden, Auckland. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.
3. *P. roseola* Ehrenberg. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.
4. ? *P. microps* Gosse. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.
5. ? *P. cloacata* Hilgendorf. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.

Genus **Rotaria** Scopoli.

1. *R. macrura* (Ehrenberg).
   Rotifer macrurus Ehrenberg. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 111.
2. *R. rotatoria* (Pallas).
   Rotifer vulgaris Schrank. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.

Subfam. HABROTROCHINAE.

Genus **Habrotrocha** Bryce.

1. *H. elegans* (Milne).
   Callidina venusta Bryce. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.

Genus **Callidina*** Ehrenberg.

1. ? *C. bihamata* Gosse. Lincoln College. Hilgendorf, Trans. N.Z. Inst., vol. 35, p. 268.
2. ? *C. quadridens* Hilgendorf. Taieri Beach. Hilgendorf, Trans. N.Z. Inst., vol. 31, p. 113.

ADDENDUM.

The Journal of the Royal Microscopical Society for October, 1913, contains a paper by Mr. James Murray, F.R.S.E., on some rotifers collected by him in Australia and New Zealand when with the Shackleton Antarctic Expedition. The New Zealand specimens were all obtained from ponds near The Hermitage, Mount Cook. Following is a list of the ten species dealt with in the paper, and, with the exception of *Monostyla bulla*, all are recorded for the first time from this country :—

Names as reported by Mr. Murray.	Names as in the Synopsis.
Monommata appendiculata Stenroos	*Monommata orbis grandis* Tessin.
Copeus caudatus Collins	*Notommata caudata* Collins.
Rattulus scipio Gosse	*Trichocerca scipio* (Gosse).
Rattulus orca Murray	*Trichocerca orca* (Murray).
Diurella insignis Herrick ..	*Diurella insignis* Herrick.
Scaridium longicaudatum Müller ..	*Scaridium longicaudum* (Müller).
Scaridium eudactylotum Gosse ..	*Scaridium eudactylotum* Gosse.
Polychaetus collinsi Gosse ..	*Macrochaetus collinsii* (Gosse).
Monostyla bulla Gosse	*Monostyla bulla* Gosse.
Pterodina striata Murray ..	*Testudinella striata* (Murray).

* As the Genus *Callidina* has been insufficiently described, it now contains a collection of doubtful species, and has been omitted from the classification table.

Art. XXX.—*List of Phanerogamic Plants Indigenous in the Southland District.*

By J. Crosby Smith, F.L.S.

[*Read before the Otago Institute, 7th October, 1913.*]

As there has not at any time been published a list of the indigenous plants of the Southland District, I have made the present effort to draw one together. The boundaries of Southland, as distinct from the Province of Otago, being ill defined, I have taken the Southland Educational District for the purposes of the present list. This district, commencing at a point

Note.—Boundary of area taken in shown thus: — · — · —

slightly east of Waikawa Harbour on the south coast, runs almost due north to Lake Wanaka, crossing over to the west of Mount Aspiring, thence following the boundary of Westland to Big Bay, taking in all the south and west coasts between Waikawa and Big Bay, and including Stewart Island. Dr. Cockayne informs me that in his forthcoming work on the

vegetation of New Zealand he is dividing this area into three botanical districts—(1) Comprising that portion subject to the average western rainfall; (2) the part subject more especially to the south-western rainfall, and in which many of the typical western plants are absent; (3) Stewart Island and the islets adjacent.

It will be seen that this covers an enormous mountain area, of which only a minute fraction has been trodden by the botanist; hence there still remains much to be done. It is probable that many more plants new to science will be discovered in this region. These, from time to time, can be collated and published as an additional list. It would have been impossible for me to have presented this list without the personal assistance of Mr. D. Petrie and Dr. L. Cockayne, F.R.S. To the works of Mr. T. F. Cheeseman, F.L.S., F.Z.S., and the reports in the "Transactions of the New Zealand Institute" on the Eyre and Garvie Mountains of Mr. D. L. Poppelwell I am much indebted.

RANUNCULACEAE.

Clematis indivisa Willd. Aug.–Nov. Common throughout open forests.
—— *hexasepala* (?) D.C. Sept.–Nov. Bluff Hill. Kirk!
—— *foetida* Raoul. Sept.–Oct. Local; not very common.
—— *marata* Armstr. Oct.–Nov. Takitimus; fairly common around Queenstown.
—— *afoliata* Buch. Near Kingston.
Myosurus aristatus Benth. Lake Wanaka.
Ranunculus Lyallii Hook. f. Nov.–Jan. Most of western sunny mountain-sides.
—— *Buchanani* Hook. f. Dec.–Jan. Mount Earnslaw, Clinton Saddle, Mount Humboldt, Eyre Mountains, Lake Harris.
—— *Traversii* Hook. f. Dec.–Jan. Mount Earnslaw.
—— *Matthewsii* Cheeseman. Dec.–Jan. Mount Earnslaw.
—— *gracilipes* Hook. f. Dec.–Jan. Common on western mountains.
—— *Baughani* Petrie. Mount Balloon.
—— *tenuicaulis* Cheeseman. Ben Lomond Clinton Saddle, Eyre Mountains.
—— *Haastii* Hook. f. Eyre Mountains.
—— *hirtus* Banks & Sol. Oct.–Feb. Common throughout.
—— *recens* Kirk. Oct.–Nov. Fortrose (sandhills), Bluff (Ward Parade).
—— *Kirkii* Petrie. Paterson Inlet, Stewart Island.
—— *lappaceus* Smith. Nov.–Feb. Common on damp land.
—— *sericophyllus* Hook. f. Bald Peak, Kinloch, Wakatipu, Lake McKenzie.
—— *foliosus* Kirk. Oct.–Dec. Hokonuis, Clinton Saddle, and common on western mountains.
—— *ternatifolius* Kirk. Dec.–Feb. Makarewa, Milford, Winton.
—— *depressus* Kirk. Foot of Lake Te Anau, Mount Cardrona.
—— *pachyrrhizus* Hook. f. Jan.–Mar. Mounts Cardrona, Hector, Tyndall, Lake Harris.
—— *rivularis* Banks & Sol. Sept.–Mar. Common on wet land and shallow water.
—— *acaulis* Banks & Sol. Sept.–Dec. Common along the coast.
—— *Crosbyi* Cockayne. Jan.–Feb. Stewart Island (Table Hill).
Caltha novae-zealandiae Hook. f. Oct.–Dec. Eyre Mountains, Clinton Saddle, Takitimu Mountains, Stewart Island (Rakeahua).
—— *obtusa* Cheeseman. Jan.–Feb. Cuthbert Peak.

Magnoliaceae.

Drimys colorata Raoul. Oct.–Nov. Common throughout district.

Cruciferae.

Nasturtium palustre D.C. Oct.–April. Common throughout, in moist places.
Cardamine heterophylla (Forst. f.) O. E. Schultz. Oct.–Dec. Common everywhere.
—— —— var. *debilis* Hook. f. Oct.–Dec. Common everywhere.
—— —— var. *uniflora* Hook. f. Nov.–Dec. Common on sea-coast.
—— *fastigiata* Hook. f. Eyre Mountains.
—— *bilobata* Kirk. Oct.–Nov. Hector Mountains.
Lepidium oleraceum Forst. Nov. Stewart Island (Kirk).
—— *tenuicaule* Kirk. Nov.–Jan. Common on all gravel beaches.
—— *kawarau* Petrie. Nov.–Dec. Gibbston, Kawarau Gorge.
—— *sisymbrioides* Hook. f. Dec.–Jan. Lake Wanaka.
Pachycladon novae-zealandiae Hook. f. Mount Alta, Mount Cardrona, Humbolt Mountains.

Violaceae.

Viola filicaulis Hook. f. Nov.–Jan. Waihopai, Takitimu Mountains, The Hump, Eyre Mountains.
—— *Lyallii* Hook. f. Jan.–Feb. Mount Cleughearn, Cuthbert Peak.
—— *Cunninghamii* Hook. f. Oct.–Jan. Common throughout.
Melicytus ramiflorus Forst. Nov.–Jan. Bluff ? Kirk ! Winton district.
—— *lanceolatus* Hook. f. Aug.–Oct. Common, but local.
Hymenanthera dentata R. Br. var. *angustifolia.* Nov.–Dec. Makarewa, Wyndham, Otautau, Clifden, Takitimus.
—— —— var. *alpina* Kirk. Eyre Mountains, Mount Earnslaw, Clinton Valley, Takitimus, Paradise, Lochy River, West Waiau.
—— *crassifolia* Hook. f. Oct.–Nov. Stewart Island.

Pittosporaceae.

Pittosporum tenuifolium Banks & Sol. Oct.–Nov. Common throughout.
—— *Colensoi* Hook. f. Oct.–Nov. Makarewa, Orepuki, Princess Range, Stewart Island.
—— *eugenioides* A. Cunn. Oct.–Nov. Common throughout lowland forests.
—— *divaricatum* Cockayne sp. ined. Clinton Valley.
—— *Buchanani* Hook. f. Eyre Mountains.
—— *Huttonianum* Kirk. Oct.–Nov. Milford Sound.
—— *rigidum* Hook. f. Nov.–Dec. Dusky Sound.

Caryophyllaceae.

Stellaria parviflora Banks & Sol. Dec.–Jan. Common.
—— *elatinoides* Hook. f. Nov.–Dec. Waihopai.
—— *Roughii* Hook. f. Dec.–Feb. Takitimu Mountains, head of River Lochy (Burnett Peak).
—— *gracilenta* Hook. f. Nov.–Feb. Takitimu Mountains, Burnett Peak, Mount Cleughearn.
Colobanthus acicularis Hook. f. Jan. Common throughout mountains.

Colobanthus Billardieri Fenzl. Nov.–Feb. Bluff, Takitimus, Stewart Island (Ringaringa).
—— *Muelleri* Kirk. Dec.–Jan. Takitimu Mountains, Fortrose, Centre Island, Dog Island.
—— *brevisepalus* Kirk. Eyre Mountains.
Spergularia media Pres[1]. Oct.–Feb. Stewart Island, on salt meadows.

PORTULACACEAE.

Claytonia australasica Hook. f. Sept.–Dec. Riverton Beach, Bluff, Takitimu Mountains, Cuthbert Peak, Stewart Island.
Montia fontana Linn. Dec.–Jan. Otatara, New River, and generally common around Invercargill Estuary.
Hectorella caespitosa Hook. f. Dec.–Jan. Ben Lomond, Mount Alta, Hector Mountains, Eyre Mountains, East Dome, Mount Burns.

ELATINACEAE.

Elatine americana Arn. Stewart Island, on wet ground.
—— —— var. *australiensis* Benth. Te Anau Lumsden.

GUTTIFERAE.

Hypericum japonicum Thunb. Dec.–Jan. Bluff, Half-way Bay, Lake Wakatipu. Stewart Island.

MALVACEAE.

Plagianthus divaricatus Forst. Oct.–Nov. Common on river and estuary flats.
—— *cymosus* Kirk. Nov. Waihopai Bush ; only one (♀) plant.
—— *betulinus* A. Cunn. Oct.–Nov. Waihopai Bush, Makarewa, Dunsdale, Wyndham, Hokonuis.
Hoheria populnea A. Cunn. var. *angustifolia* Hook. f. Nov. Waihopai, Winton, Wyndham, Seaward Bush.
Gaya Lyallii (Hook. f.) J. E. Baker. Dec.–Feb. Mossburn, Beaumont Hill, Nightcaps, Hector Mountains, Eyre Mountains, and abundant from subalpine scrub to sea-level.

TILIACEAE.

Aristotelia racemosa Hook. f. Sept.–Nov. Common throughout.
—— *Colensoi* Hook. f. Oct.–Nov. Waihopai, Colac Bay.
—— *fruticosa* Hook. f. Oct.–Nov. Common, sea-level to 4,000 ft.

ELAEOCARPACEAE.

Ealeocarpus Hookerianus Raoul. Jan. Common.

LINACEAE.

Linum monogynum Forst. Oct.–Jan. Common along coast, and ascending 2,000 ft.

GERANIACEAE.

Geranium microphyllum Hook. f. Nov.–Mar. Abundant.
—— *sessiliflorum* Cav. Nov.–Feb. On all sand-flats, ascending 3,000 ft.
Pelargonium australe Jacq. Nov.–Feb. Shady places on bush tracks.

Oxalis corniculata Linn. Nov.–Jan. Bluff Hill, Blackmount, river-flats generally.
—— *magellanica* Forst. Jan.–Feb. The Hump, Hauroko district, Eyre Mountains, Cuthbert Peak, Waiau, Lake Harris.

Rutaceae.

Melicope simplex A. Cunn. Sept.–Oct. Mixed bush throughout.

Olacinaceae.

Pennantia corymbosa Forst. Nov.–Dec. Waihopai, Hokonuis, Wyndham.

Rhamnaceae.

Discaria toumatou Raoul. Nov.–Dec. Common on open lands, ascending to 3,000 ft. Not at Stewart Island.

Coriariaceae.

Coriaria ruscifolia Linn. Nov.–Jan. Abundant.
—— *thymifolia* Humb. & Bonp. Dec.–Jan. Princess Range, Milford Track, Takitimus, The Hump, Eyre Mountains, Mount Cleughearn, Stewart Island.
—— *angustissima* Hook. f. Dec.–Jan. Same localities; common on western mountains.

Leguminosae.

Corallospartium crassicaule J. B. Armstr. Dec.–Jan. Mount Roy, Wanaka, Queenstown, Eyre Mountains.
Notospartium Carmichaeliae Hook. f. Dec.–Jan. Lake Wakatipu.
Carmichaelia grandiflora Hook. f. Dec.–Jan. Bald Peak, Kinloch, Clinton Saddle.
—— *flagelliformis* Col. Nov.–Jan. Common around Wakatipu.
—— *subulata* Kirk. Common.
—— *virgata* Kirk. Nov.–Dec. Makarewa, Orepuki.
Sophora tetraptera J. Mull. var. *microphylla* Hook f. Nov.–Dec. Common throughout. Not at Stewart Island.

Rosaceae.

Rubus australis Forst. Sept.–Oct. Abundant.
—— *cissoides* A. Cunn. Oct.–Dec. In the open bush throughout.
—— *schmidelioides* A. Cunn. Oct.–Dec. Common throughout.
—— —— var. *coloratus* Kirk. Stewart Island (rare); near Thule Bay, Paterson Inlet; Mason Bay.
—— *subpauperatus* Cockayne. Fairly common throughout; rare Stewart Island.
Geum parviflorum Sm. Dec.–Feb. Ben Lomond, Takitimus, Clinton Saddle, Eyre Mountains.
—— *uniflorum* Buch. Jan.–Feb. Takitimus, Eyre Mountains, Lake Harris, Mount Cleughearn.
—— *leiospermum* Petrie. Dec.–Jan. Ben Lomond, Mount Cardrona, Cuthbert Peak.
—— *urbanum* var. *strictum* Linn. Nov.–Jan. Waikaka.

Potentilla anserina Linn. Nov.–Jan. Becoming common weed; rare Stewart Island.
—— —— var. *anserinoides* Raoul.
Acaena novae-zealandiae Kirk. Nov.–Jan. Common.
—— *Sanguisorbae* Vahl. Nov.–Jan. Sandy flats throughout.
—— —— var. *pilosa* Kirk. Nov.–Jan. Not very common.
—— *microphylla* Hook. f Nov.–Jan. Riverton Beach, Takitimus, Fortrose, Eyre Mountains, River Lochy.
—— *Buchanani* Hook. f. var. *longe filamentosa* Bittel. Riverton Beach, Takitimus, Fortrose.
—— *adscendens* Vahl. Dec.–Jan. Lake Wakatipu, Takitimus, Hector Mountains.
—— *glabra* Buch. Jan.–Feb. Lake Harris.

SAXIFRAGACEAE.

Donatia novae-zealandiae Hook. f. Dec.–Jan. Common on all alpine moors.
Carpodetus serratus Forst. Dec.–Jan. Common throughout up to 1,500 ft.

CUNONIACEAE.

Weinmannia racemosa Linn. Dec.–Jan. Common throughout south-eastern coastal forests.

CRASSULACEAE.

Crassula moschata D.C. Nov.–Jan. All along the coast.
—— *diffusa* Kirk. Dec.–Jan. Stewart Island.
—— *Sinclairii* Hook. f. Dec.–Jan. Winton.
—— *acutifolia* Kirk. Jan.–Feb. Dunsdale, Winton.
—— *multicaulis* Petrie. Dec.–Jan. Bluff Hill.
—— *purpurata* Hook. f. Otahu Flat near Clifden, Lake Wanaka.

DROSERACEAE.

Drosera stenopetala Hook. f. Dec.–Feb. Common on all alpine moors.
—— *Arcturi* Hook. f. Dec.–Jan. Common on all alpine moors.
—— *pygmaea* D.C. Jan.–Feb. Bluff Hill, Wyndham Valley; rare.
—— *spathulata* Labill. Dec.–Jan. Common on all bog flats.
—— *binata* Labill. Dec.–Jan. Common on all bog flats.

HALORRHAGACEAE.

Halorrhagis erecta Schind. Dec.–Feb. Fairly common.
—— *depressa* Walp. Nov.–Jan. Abundant.
—— *procumbens* Cheeseman. Fairly common, Stewart Island.
—— —— var. *serpyllifolia* Benth. Nov.–Jan. Fairly common.
—— *micrantha* R. Br. Nov.–Jan. Abundant, sea-level to 3,000 ft.
Myriophyllum elatinoides Gaud. Nov.–Feb. Most rivers and lakes.
—— *intermedium* D.C. Dec.–Mar. Stewart Island.
—— *pedunculatum* Hook. f. Dec.–Feb. Blackmount, Fortrose, Lake Hauroko, Bluff Hill.
Gunnera monoica Raoul. Nov.–Jan. Abundant on all damp places.
—— *prorepens* Hook. f. Stewart Island (on old dunes, Mason Bay and Rakeahua Valley).

Gunnera albocarpa (Kirk) Cockayne. Nov. Common.
—— *dentata* Kirk. Dec.–Jan. Lowther, Milford Track, Seaward Bush, Dart and Routeburn Valleys.
—— *arenaria* Cheeseman. Dec.–Jan. Sandy Point, Stewart Island (Mason Bay).
—— *Hamiltonii* Kirk. Oreti Mouth, Bluff, Mount Cleughearn, Stewart Island (Mason Bay). Common around Invercargill.
Callitriche verna Linn. Nov.–Dec. Abundant in most streams and lakes.
—— *Muelleri* Sond. Waihopai, and generally on damp ground, Stewart Island.

Myrtaceae.

Leptospermum scoparium Forst. Oct.–Mar. Abundant.
—— —— var. *myrtifolium* Hook. f. Kingston district.
Metrosideros lucida Rich. Dec.–Jan. Abundant throughout mixed forest.
—— *hypericifolia* A. Cunn. Dec.–Feb. Common on trees and rocks throughout.
Myrtus obcordata Hook. f. Dec.–Jan. Winton district; rare.
—— *pendunculata* Hook. f. Dec.–Jan. Abundant throughout.

Onagraceae.

Epilobium pallidiflorum Sol. Dec.–Feb. Abundant in marshes throughout.
—— *chionanthum* Haussk. Nov.–Feb. Abundant in ditches and damp ground.
—— *Billardierianum* Ser. Nov.–Feb. South Hillend, Seaward Bush, Stewart Island.
—— *chloraefolium* Haussk. Nov.–Mar. Eyre Mountains, Clinton Saddle.
—— *junceum* Sol. Nov.–Feb. Dunsdale, Hokonuis, Stewart Island.
—— *pubens* A. Rich. Nov.–Feb. Bluff, Blackmount, Stewart Island, Hokonuis, and common throughout.
—— *tasmanicum* Haussk. Abundant in most high mountains.
—— *pictum* Petrie. Dec.–Feb. Hokonuis, Routeburn Valley, Eyre Mountains, Mount Cleughearn.
—— *tenuipes* Hook. f. Takitimus.
—— *Hectori* Haussk. Dec.–Feb. Lower Takitimus.
—— *alsinoides* A. Cunn. Nov.–Feb. Abundant.
—— *rotundifolium* Forst. Nov.–Feb. Abundant.
—— *insulare* Haussk. Dec.–Feb. Hokonuis, Dunsdale, Seaward Bush, Clinton Valley.
—— *linnaeoides* Hook. f. Dec.–Feb. Common.
—— *nummularifolium* A. Cunn. Dec.–Feb. Abundant.
—— —— var. *pedunculare* Hook. f. Dec.–Feb. Bluff, Lake Hauroko, Clinton Valley, Stewart Island.
—— *mimimum* Kirk. Base of Bluff Hill, West Coast Sounds, and Stewart Island.
—— *caespitosum* Haussk. Bluff, Fortrose.
—— *macropus* Hook. f. Dec.–Mar. Lake Harris, Hector Mountains, Mount Cleughearn, Routeburn.
—— *melanocaulon* Hook. f. Dec.–Feb. Te Anau, Queenstown, Mount Cleughearn; abundant in stony river-beds.
—— *glabellum* Forst. Dec.–Feb. Abundant; not at Stewart Island.
—— *arcuatum* Petrie. Clinton Valley, McKinnon's Pass.

Fuchsia excorticata Linn. f. Sept.–Jan. Abundant.
—— *Colensoi* Hook. f. Oct.–Feb. Waihopai, Wyndham, Makarewa, Seaward Bush, Hokonuis, Stewart Island.

AIZOACEAE.

Mesembryanthemum australe Sol. Nov.–Mar. Most coastal cliffs.
Tetragonia expansa Murr. Nov.–Dec. Ruapuke, Stewart Island.
—— *trigyna* Banks & Sol. Dec.–Feb. On most beaches.

UMBELLIFERAE.

Hydrocotyle tripartita R. Br. Dec.–Feb. Bluff Hill, Riverton Beach, Stewart Island (Mason Bay).
—— —— var. *hydrophila* Petrie. Dec.–Feb. Bluff.
—— *moschata* Forst. Nov.–Feb. Bob's Cove, Mount Cleughearn, Burnett Peak, Routeburn Valley.
—— *americana* Linn. Dec.–Feb. Abundant on damp soil.
—— *asiatica* Linn. Dec.–Feb. Abundant on damp soil.
—— *microphylla* A. Cunn. Dec.–Feb. Blackmount, Takitimus, Stewart Island.
—— *novae-zealandiae* D.C. Dec.–Feb. Common.
Azorella Haastii Benth. & Hook. Dec.–Feb. Takitimus.
—— *Hookeri* Drude. Takitimus, Hokonuis.
—— *hydrocotyloides* Benth & Hook. f. Eyre Mountains.
—— *nitens* Petrie. Dec.–Jan. Lake Te Anau, Clinton Valley, Blackmount.
—— *Cockaynei* Diels. Stewart Island (Mason Bay).
Actinotus novae-zealandiae Petrie. Jan.–Feb. Wet bogs, mainland and Stewart Island.
Apium prostratum Labill. Nov.–Mar. Common on coastal rocks.
Oreomyrrhis andicola Endl. Nov.–Feb. Longwood Range, Matukituki Valley, Stewart Island, Takitimus, Rakeahua Valley.
Crantzia lineata Nutt. Nov.–Jan. Hard sand-flats throughout.
Aciphylla Colensoi Hook. f. Dec.–Jan. Queenstown, Takitimus, Humboldts, Eyre Mountains.
—— *squarrosa* Forst. Nov.–Jan. Common, sea-level to 3,000 ft.
—— *Lyallii* Hook. f. Dec.–Jan. Te Anau, Lake Wanaka, Clinton Valley, Mount Burns.
—— *Hectori* Buch. Jan.–Feb. Hector's Col, Mount Aspiring.
—— *Traillii* Kirk. Dec.–Jan. Stewart Island.
—— *Kirkii* Buch. Jan. Hector Mountains, Mount Alta.
—— *pinnatifida* Petrie. Jan.–Feb. Princess Range, Garvie Mountains.
—— *Monroi* Hook. f. Dec.–Jan. Hector Mountains.
—— *Spedeni* Cheeseman. Walter Peak, Eyre Mountains.
—— *Crosby-Smithii* Petrie sp. nov. ined. Jan.–Feb. Mount Cleughearn.
Anisotome intermedia Hook. f. Dec.–Jan. Waikawa Cliffs, Stewart Island; common, but only to south and west of island.
—— *Lyallii* Hook. f. Dec.–Jan. Sounds, south-west coast.
—— *Haastii* Cockayne and Laing. Dec.–Jan. Takitimus, Princess Range, The Hump, Clinton Valley, Mount Cleughearn.
—— *aromatica* Hook. f. Dec.–Jan. Takitimus, Princess Range, Hump, Clinton Valley, Cuthbert Peak.
—— *petraea* Cheeseman. Dec.–Jan. Takitimus.

Anisotome flabellata Cockayne. Jan.–Feb. Stewart Island; confined to south and west of island.
—— *pilifera* Hook. f. Eyre Mountains.
—— *imbricata* Hook. f. Jan.–Feb. Not uncommon in western mountains.
—— *brevistylis* Hook. f. Eyre Mountains.
Angelica Gingidium Hook. f. Nov.–Jan. Fairly common, but rapidly disappearing.
Daucus brachiatus Sieb. Nov.–Jan. Queenstown.

Araliaceae.

Stilbocarpa Lyallii J. B. Armstr. Dec.–Feb. Coal Island, Preservation Inlet, Stewart Island; common on Mutton-bird Island.
Nothopanax lineare Harms. Jan.–Feb. Lake Hauroko and Hump forest, Preservation Inlet, Mount Cleughearn forest.
—— *simplex* Seem. Nov.–Jan. Common throughout.
—— *parvum* Cockayne. Stewart Island; not abundant.
—— *Edgerleyi* Harms. Jan.–Feb. Fairly common.
—— *anomalum* Seem. Dec.–Feb. Stewart Island (Rakeahua Valley), Hokonuis.
—— *Colensoi* Seem. Dec.–Feb. Abundant up to 3,000 ft.
—— *arboreum* Seem. July-Aug. Lake Hauroko and Hump forests, Mount Cleughearn forest.
Schefflera digitata Forst. Jan.–Feb. Common throughout.
Pseudopanax crassifolium C. Koch var. *unifoliatum* Kirk. Feb.–April. Abundant throughout.
—— *ferox* Kirk. Feb.–Mar. Wakatipu, Hokonuis, Clifden, Wanaka, Crescent Island, Mount Sunnyside, Waiau.

Cornaceae.

Corokia Cotoneaster Raoul. Nov. Waihopai, Makarewa, Mount Linton, Takitimus, River Lochy, Wakatipu.
Griselinia littoralis Raoul. Abundant throughout.

Rubiaceae.

Coprosma lucida Forst. Sept.–Oct. Common throughout the district.
—— *serrulata* Hook. f. Nov.–Jan. Common to all western mountains.
—— *Cunninghamii* Hook. f. Aug.–Sept. Makarewa.
—— *rotundifolia* A. Cunn. Sept.–Oct. Common.
—— *areolata* Cheeseman. Sept.–Oct. Waihopai, Hokonuis, Stewart Island.
—— *rhamnoides* A. Cunn. Sept.–Nov. Eyre Mountains and Clinton Valley, Waihopai; abundant.
—— *parviflora* Hook. f. Oct.–Nov. Waihopai, Hokonuis, Seaward Bush, Clinton Valley, Stewart Island, Eyre Mountains.
—— *ramulosa* Petrie. Sept.–Oct. Fairfax, Otautau, Clinton Valley, Hokonuis, Stewart Island (Mount Anglem, Table Hill), Eyre Mountains.
—— *ciliata* Hook. f. Sept.–Oct. Fairly common in mountains.
—— *crassifolia* Col. Sept.–Oct. Hokonuis, Waihopai, Seaward Bush.
—— *rigida* Cheeseman. Sept.–Oct. Waihopai, Orepuki.
—— *rubra* Petrie. Sept.–Nov. Clifden.
—— *virescens* Petrie. Sept.–Oct. Clifden, Wyndham.
—— *acerosa* A. Cunn. Sept.–Nov. Common on sand-dunes.

Coprosma propinqua A. Cunn. Sept.–Oct. Abundant.
—— *linariifolia* Hook. f. Oct.–Nov. Common.
—— *foetidissima* Forst. Aug.–Oct. Abundant.
—— *Colensoi* Hook. f. Nov.–Jan. Longwood forest and all western forests, Hokonuis, Stewart Island.
—— *Banksii* Petrie. Nov.–Jan. Longwood forest. Takitimus, Stewart Island (in forest).
—— *retusa* Petrie. Dec.–Jan. Clinton Saddle, Lake Te Anau, Longwoods, Table Hill.
—— *cuneata* Petrie. Nov.–Jan. Longwoods, Takitimus, and in all mountain scrubs, Stewart Island.
—— *repens* Hook. f. Dec.–Jan. Longwoods, Eyre Mountains, Stewart Island; abundant on all high mountains.
—— *rugosa* Cheeseman. Blackmount, Longwoods, Eyre Mountains, Mount Cleughearn.
—— *Astoni* Petrie. Longwoods, Stewart Island (Rakeahua Mountain).
Nertera depressa Banks & Sol. Oct.–Feb. Common throughout.
—— *dichondraefolia* Hook. f. Nov.–Jan. Common throughout.
—— *setulosa* Hook. f. Nov.–Jan. Fortrose, Bluff, Stewart Island.
Galium umbrosum Sol. Nov.–Mar. Common on damp ground.
Asperula perpusilla Hook. f. Nov.–Feb. Fortrose, Woodend, Takitimus, Ocean Beach.

COMPOSITAE.

Lagenophora pumila Cheeseman. Oct.–Mar. Abundant.
—— *petiolata* Hook. f. Oct.–Mar. Abundant.
—— *Barkeri* Kirk. Dec.–Feb. Clinton Valley, in the open.
—— *pinnatifida* Hook. f. Dec.–Jan. Routeburn Valley.
Brachycome lineata Kirk. Jan.–Feb. Te Anau.
—— *Sinclairii* Hook. f. Dec.–Feb. Takitimus, Hector, Eyre Mountains, and all higher mountains.
—— *odorata* Hook. f. Fortrose.
—— *Thomsoni* Kirk. Dec.–Jan. Stewart Island, Bluff (Ward Parade), Arrow.
—— —— var. *polita* Kirk. Jan.–Feb. Mount Cleughearn.
Olearia operina Hook. f. Dec.–Jan. Coastal scrub, West Coast Sounds in general.
—— *angustifolia* Hook. f. Nov. Puysegur Point, Bluff (Ward Parade), Stewart Island (Paterson Inlet, and coast to south and west).
—— *Traillii* Kirk. Nov.–Dec. Stewart Island, very local; growing with *O. angustifolia* on coast.
—— *Colensoi* Hook. f. Dec.–Jan. South-west Sounds, Stewart Island; common on coast, especially to south and west of Paterson Inlet.
—— *arborescens* (Forst. f.) Cockayne and Laing. Nov.–Dec. Bluff Hill, Oreti Mouth, Eyre Mountains, Tewaewae Bay, Stewart Island.
—— *macrodonta* Baker. Jan.–Feb. Very local.
—— *ilicifolia* Hook. f. Jan.–Feb. Waikawa, Clinton Valley, Stewart Island; rare.
—— *lacunosa* Hook f. Oct.–Nov. Steep slopes, Cuthbert Peak, Fiord County.
—— *Crosby-Smithiana* Petrie. Jan.-Feb. Princess Range (End Peak).
—— *moschata* Hook. f. Jan.–Feb. Clinton Saddle, Humboldt, Takitimu, and Eyre Mountains.

Olearia oleifolia Kirk. Jan.–Feb. Resolution Island, Routeburn Valley.
—— *nummularifolia* Hook. f. Jan.–Feb. Wairaki district, Colac Bay, Eyre Mountains.
—— *avicenniaefolia* Hook. f. Jan.–Feb. Waiau Beach, Preservation Inlet Track, Stewart Island, Eyre Mountains.
—— *fragrantissima* Petrie. Nov.–Dec. Wyndham.
—— *odorata* Petrie. Jan.–Feb. Head of Lochy River.
—— *Hectori* Hook. f. Oct.–Nov. Wyndham, Otautau, Matukituki Valley.
—— *divaricata* Cockayne. Stewart Island.
—— *virgata* Hook. f. var. *lineata* Kirk. Nov.–Dec. Banks of rivers and mountain-valleys throughout.
—— *Willcoxii* Petrie. Queenstown.
Celmisia Walkeri Kirk. Dec.–Feb. Most mountains above 3,000 ft.; not recorded from Stewart Island.
—— *ramulosa* Hook. f. Jan. Princess Range, Clinton Saddle, Cecil Peak, Eyre Mountains.
—— *holosericea* Hook. f. Dec.–Jan. Clinton Saddle.
—— *prorepens* Petrie. Dec.–Jan. Eyre Mountains, Walter Peaks, Lake Monowai Flat.
—— *densiflora* Hook. f. Dec.–Jan. Mount Beaumont, Takitimus, Mount Burnett, Lake Wakatipu.
—— *discolor* Hook. f. Dec.–Feb. All mountains above 3,000 ft.
—— *Lindsayi* Hook. f. Jan.–Feb. Wairaki district, Waikawa.
—— *Sinclairii* Hook. f. Dec.–Jan. Clinton Valley, Eyre Mountains, Stewart Island (Mount Anglem).
—— *Traversii* Hook. f. Dec.–Jan. The Hump, Cuthbert Peak, West Waiau.
—— *petiolata* Hook. f. Dec.–Jan. Eyre Mountains.
—— *verbascifolia* (= *Brownii*) Hook. f. Dec.–Feb. Eyre Mountains, Preservation Inlet, Milford Sound, Clinton Saddle, Cuthbert Peak.
—— *coriacea* Hook. f. Dec.–Feb. Some form of this very varied species is to be found on all mountains.
—— —— var. *stricta* Cockayne. Takitimus.
—— *lanceolata* Cockayne. Jan.–Feb. Longwood Range, The Hump, Cuthbert Peak.
—— *Petriei* Cheeseman. Dec.–Jan. Clinton Saddle, Princess Range, Humbolt Mountains, Lake Te Anau.
—— *Lyallii* Hook. f. Dec.–Jan. Takitimus, Eyre Mountains.
—— *rigida* (Kirk) Cockayne. Dec.–Jan. Stewart Island.
—— *longifolia* Cass. Nov.–Mar. Common on all virgin land.
—— *spectabilis* Hook. f. Dec.–Jan. Eyre Mountains.
—— *linearis* Armstr. Dec.–Jan. Longwoods, Stewart Island.
—— *Haastii* Hook. f. Dec.–Jan. Eyre Mountains.
—— *laricifoia* Hook. f. Dec.–Jan. All mountains; not noted at Stewart Island.
—— *Hectori* Hook. f. Jan.–Feb. Remarkables, Mount Earnslaw, Mount Alta, Eyre Mountains.
—— *Poppelwellii* Petrie sp. nov. ined. Jan.–Feb. Stewart Island, Mount Cleughearn.
—— *sessiliflora* Hook. f. Dec.–Jan. All mountains above 3,000 ft.
—— *argentea* Kirk. Dec.–Jan. Princess Range, Takitimus, Clinton Saddle, Mount Cleughearn, Stewart Island.

Celmisia bellidioides Kirk. Dec.–Jan. Longwoods, Princess Range (Cecil Peak), Takitimus, Eyre Mountains.
—— *glandulosa* Hook. f. Dec.–Jan. Clinton Valley, Takitimus.
—— *viscosa* Hook. f. Jan. Takitimus.
Vittadinia australis A. Rich. Nov.–Feb. Common around Lake Wakatipu.
Haastia Sinclairii Hook f. Dec.–Feb. Shingle-slope, Mount Burns.
Gnaphalium Lyallii Forst. Jan. Milford Sound, Stewart Island.
—— *Traversii* Hook. f. Dec.–Feb. Princess Range, Blackmount, and most mountains except Stewart Island.
—— *japonicum* Thunb. Nov.–Jan. Common throughout.
—— *paludosum* Petrie. Dec.–Jan. Eyre Mountains.
—— *luteo-album* Linn. Nov.–Mar. Eyre Mountains; common throughout.
—— *collinum* Labill. Nov.–Mar. Common in virgin pastures.
—— *trinerve* Forst. f. Common throughout.
Raoulia australis Hook. f. Dec.–Feb. Most hard sand-dunes.
—— *Beauverdii* Cockayne sp. nov. Sand-dunes throughout district.
—— *tenuicaulis* Hook. f. Dec.–Jan. Preservation Track, The Hump.
—— *glabra* Hook. f. Dec.–Feb. Near Mason Bay, Stewart Island, and throughout all high hills on mainland.
—— *Haastii* Hook. f. Mararoa River beds.
—— *subsericea* Hook. f. Dec.–Feb. Abundant on lower mountains.
—— *grandiflora* Hook. f. Dec.–Jan. Takitimus, Princess, and Eyre Mountains.
—— *Parkii* Buch. Dec.–Jan. Mounts Alta and Hector, Lake Wanaka, Ben Lomond.
—— *Hectori* Hook. f. Dec.–Jan. Ben Lomond, Hector Mountains, Mount Pisa.
—— *eximia* Hook. f. Dec.–Jan. Alps of Lake district.
—— *Buchanani* Kirk. Clinton Saddle, Lake Harris, Mount Alta, Humboldt Mountains.
—— *Goyeni* Kirk. Jan.–Feb. Stewart Island (Mount Anglem, Table Hill, Rakeahua).
—— *bryoides* Hook. f. Dec.–Jan. Hector Mountains.
Helichrysum bellidioides Willd. Nov.–Feb. Common throughout.
—— *filicaule* Hook. f. Dec.–Feb. Common throughout on dry grassy places.
—— *glomeratum* Benth. & Hook. f. Jan.–Feb. Eyre Mountains.
—— *Youngii* Hook. f. Jan. Lake Wanaka, Mounts Cardrona and Hector.
—— *microphyllum* Benth. & Hook. Jan.–Mar. Takitimus.
—— *Selago* (Hook. f.) Benth and Hook. f. Dec.–Jan. Eyre Mountains, Takitimu Mountains.
Cassinia Vauvilliersii Hook. f. Dec.–Jan. Abundant throughout.
—— *fulvida* Hook. f. Dec.–Feb. Rare; Blackmount, Seaward Bush.
Craspedia uniflora Forst. Dec.–Feb. Common.
—— —— var. *robusta* Kirk. Jan.–Feb. Mason Bay, Clinton Valley.
—— —— var. *lanata* Hook f. Jan.–Feb. Head of River Lochy.
Cotula coronopifolia Linn. Oct.–Feb. All marshy ground; rare Stewart Island.
—— *plumosa* Hook. f. Dec.–Jan. Western side of Bluff Hill.
—— *perpusilla* Hook. f. Nov.–Feb. Gibbston.
—— *Traillii* Kirk. Dec.–Feb. Bluff (Ward Parade), Dog Island, Stewart Island; sand-dunes.

Cotula maniototo Petrie. Jan.–Feb. Mossburn, Te Anau, Hokonuis.
—— *squalida* Hook. f. Dec.–Feb. Bluff Hill, Blackmount, Clinton Valley, Lake Wakatipu.
—— *dioica* Hook. f. Nov.–Feb. Common throughout, but not observed at Stewart Island.
—— *pulchella* Kirk. Dog and Centre Islands.
—— *pectinata* Hook. f. Dec.–Jan. Common in mountain districts.
Abrotanella linearis Bergg. Dec.–Jan. Stewart Island.
—— *inconspicua* Hook. f. Dec.–Jan. Ben Lomond, Mount Alta, Eyre Mountains, East Dome.
—— *muscosa* Kirk. Jan. Stewart Island (Table Hill, Rakeahua).
Erechtites prenanthoides D.C. Nov.–Feb. Common throughout bush clearings.
—— *arguta* D.C. Nov.–Feb. Common throughout bush clearings.
—— *scaberula* Hook. f. Nov.–Feb. Stewart Island.
—— *quadridentata* D.C. Nov.–Jan. Stewart Island.
—— *glabrescens* Kirk. Jan.–Feb. Bluff Hill, Clinton Valley, Takitimus, Mount Cleughearn, Stewart Island.
—— *diversifolia* Petrie. Dec.–Jan. Bluff, Stewart Island heath.
Senecio lagopus Raoul. Nov.–Jan. Waikaka, Garvie Mountains.
—— *bellidioides* Hook. f. Dec.–Feb. Common on all high ground.
—— *Haastii* Hook. f. Dec.–Jan. Wairaki (above Nightcaps).
—— *Lyallii* Hook. f. Dec.–Feb. All mountains above 2,000 ft.
—— *scorzoneroides* Hook. f. Dec.–Feb. Princess Range, Clinton Saddle, Takitimus, Lake Harris, Mount Cleughearn, Stewart Island (Table Hill).
—— *lautus* Forster. Oct.–Mar. Oreti Mouth, Takitimus, Stewart Island.
—— *Stewartiae* J. B. Armstr. Dec.–Jan. Stewart Island (Mutton-bird Islands).
—— *revolutus* Kirk. Jan.–Mar. Princess Range, The Hump, Ben Lomond, Takitimus, Mount Cleughearn, Eyre Mountains.
—— *bifistulosus* Hook. f. Dusky Bay.
—— *elaeagnifolius* Hook. f. Dec.–Jan. Longwoods, Orepuki, The Hump, Clinton Valley, Stewart Island, West Coast Sounds.
—— —— var. *Buchanani* Kirk. Jan.–Feb. Cuthbert Peak.
—— *rotundifolius* Hook. f. Dec.–Feb. Bluff Hill, Preservation Track, Milford, and Stewart Island, where it forms the chief coastal scrub.
—— *cassinioides* Hook. f. Jan.–Feb. Wairaki, above Nightcaps, Takitimus, Eyre Mountains, Mount Earnslaw, Cecil Peak.
Microseris Forsteri Hook. f. Dec.–Feb. Blackmount.
Taraxacum magellanicum Comm. Dec.–Feb. Takitimus, Hokonuis, mountains of the west.
Sonchus oleraceus Linn. Nov.–Mar. Plentiful throughout.
—— *littoralis* Cockayne. Nov.–Mar. Stewart Island (Mason Bay).

Stylidiaceae.

Phyllachne clavigera Muell. Dec.–Mar. Takitimus, Princess Range, Stewart Island (Mount Anglem), Eyre Mountains, Mount Cleughearn, Mount Burns.
—— *Colensoi* Bergg. Dec.–Feb. Takitimus and all Stewart Island mountains.

Oreostylidium subulatum Bergg. Dec.–Feb. Common on damp gravelly or peaty soils.
Forstera sedifolia Linn. Dec.–Mar. All mountains above 3,000 ft.
—— *tenella* Hook. Dec.–Mar. Princess Range, Takitimus, Clinton Saddle.
—— —— var. *oculata* Cheeseman. Dec.–Feb. Longwoods, Stewart Island, Mounts Earnslaw and Cleughearn.
Selliera radicans Cav. Nov.–Feb. Common on muddy places.

CAMPANULACEAE.

Pratia angulata Hook. f. Nov.–Feb. Common, sea-level up to 4,000 ft.
—— *macrodon* Hook. f. Dec.–Feb. Hector Mountains, Mount Cardrona, Clinton Valley.
Lobelia linnaeoides Petrie. Ben Lomond; Mounts Cardrona, Pisa, Hector, Tyndall; Eyre Mountains, Burnett Peak.
Isotoma fluviatilis Muell. Dec.–Feb. Outlet of Lake Hauroko.
Wahlenbergia gracilis A. D.C. Dec.–Feb. Common, sea-level to 4,000 ft.
—— *saxicola* R. Br. Dec.–Feb. Most dry hilly ground.
—— *Morgani* Petrie. Sandhills, Fortrose.

ERICACEAE.

Gaultheria antipoda Forst. Dec.–Feb. Princess Range, The Hump, Eyre Mountains.
—— —— var. *depressa* Hook. f. Dec.–Feb. Princess Range, The Hump, Eyre Mountains, and Stewart Island; most high mountains.
—— —— var. *erecta* Hook. f. Dec.–Feb. The Hump, Eyre Mountains, Stewart Island.
—— *perplexa* Kirk. Nov.–Feb. Sea-level to 3,000 ft.
—— *rupestris* R. Br. Nov.–Feb. Takitimus, The Hump, Eyre Mountains, Mount Cleughearn.
Pernettya nana Col. Dec.–Feb. Hector Mountains, Mount Bonpland.
Pentachondra pumila R. Br. Dec.–Feb. Princess Range, Takitimus, Mount Burns, Clinton Saddle, Eyre Mountains, Stewart Island.
Styphelia acerosa R. Br. Aug.–Nov. Bluff Hill, Awarua Plains, Greenhills, Lake Wakatipu, Stewart Island.
—— *empetrifolia* Hook. f. Nov.–Jan. Woodend, Waimahaka, Cuthbert Peak, Takitimus, all western mountains, Stewart Island.
—— *pumila* Hook. f. Feb.–Mar. Princess Range, Takitimus, Mount Cleughearn.
Leucopogon Fraseri A. Cunn. Sept.–Jan. Common on dry heaths.
Archeria Traversii Hook. f. Jan.–Feb. Princess Range, Clinton Valley, The Hump, and most bush-clad mountains.
Dracophyllum Menziesii Hook. f. Jan.–Feb. The Hump, Mounts Humboldt and Bonpland, Preservation Inlet, Dusky Sound, Lake Harris, Stewart Island (Mount Anglem).
—— *longifolium* R. Br. Nov.–Mar. Common, sea-level to 3,000 ft.
—— *Urvilleanum* A. Rich. var. *montanum* Kirk. Eyre Mountains, Paterson Inlet (?). Kirk.
—— *Pearsoni* Kirk. Jan.–Feb. Takitimus, Stewart Island (Mount Anglem, Smith's Lookout).
—— *rosmarinifolium* var. *politum* R. Br. Dec.–Mar. Stewart Island (Mount Anglem).

Dracophyllum prostratum Kirk. Dec.–Feb. Clinton Valley, Longwoods, The Hump, Lake Harris, Eyre Mountains.
—— *uniflorum* Hook. f. Subalpine scrub, Takitimu Mountains ; also river-terrace scrub near Lake Wakatipu.

Primulaceae.

Samolus repens Pers. Nov.–Feb. Common on all coasts.

Myrsinaceae.

Myrsine Urvillei A. D.C. Jan.–Mar. Abundant throughout.
—— *chathamica* F. Muell. Sept.–Oct. Stewart Island (Wilson's Bay).
—— *divaricata* A. Cunn. Aug.–Oct. Common throughout.
—— *nummularia* Hook. f. Dec.–Jan. Clinton Saddle, Takitimus, Eyre Mountains, Wyndham, Mount Cleughearn, River Lochy, Stewart Island (Mount Anglem).

Apocynaceae.

Parsonsia heterophylla A. Cunn. Nov.–Jan. Abundant everywhere.
—— *capsularis* R. Br. Nov.–Dec. Greenhills ; very rare

Loganiaceae.

Mitrasacme novae-zealandiae Hook. f. Stewart Island (Fraser Peaks, Rakeahua, Smith's Lookout).

Gentianaceae.

Gentiana lineata Kirk. Jan.–Mar. Longwood heath, Otatara Road, Invercargill, Stewart Island.
—— *Grisebachii* Hook. f. Dec.–Feb. Dunsdale, Stewart Island.
—— *corymbifera* Kirk. Jan.–Mar. Princess Range, Ben Lomond, Eyre Mountains.
—— *montana* Forst. Jan.–Mar. Dusky Bay.
—— *patula* Cheeseman. Jan.–Mar. Abundant throughout mountain districts.
—— *flaccida* Petrie. Jan.–Mar. Princess Range.
—— *saxosa* Forst. Jan.–Mar. Abundant on the coast.
—— *bellidifolia* Hook. f. Jan.–Mar. Eyre Mountains.
—— *Matthewsii* Petrie. Lake Harris.
Liparophyllum Gunnii Hook. f. Jan.–Feb. Longwood Range, Stewart Island.
Myosotis pulvinaris Hook. f. Jan.–Mar. Mount Hector, Mount Cardrona, Eyre Mountains.
—— *macrantha* Hook. f. Dec.–Jan. Eyre Mountains, Clinton Saddle, Ben Lomond.
—— *Cheesemanii* Petrie. Hector Mountains.
—— *antarctica* Hook. f. Nov.–Feb. Bluff, Fortrose, Clinton Saddle, Riverton Beach, Stewart Island.
—— *australis* R. Br. Dec.–Feb. Ben Lomond, Fairlight.

Myosotis Forsteri Lehm. Oct.–Feb. Clinton Valley.
—— *albida* Cheeseman. Dec.–Feb. Bluff cliffs, Preservation Inlet Road.
—— *Goyeni* Petrie. Nov.–Jan. Near cemetery, Queenstown; Mount Roy, Queenstown; Wakatipu.
—— *spathulata* Forst. Nov.–Jan. Winton.
—— *Lyallii* Hook. f. Milford.
Tetrachondra Hamiltonii Petrie. Makarewa River.

CONVOLVULACEAE.

Calystegia tuguriorum R. Br. Dec.–Feb. Fairly common on the edges of bush clearings.
—— *Soldanella* R. Br. Nov.–Mar. Abundant on all sand-dunes.
Dichondra brevifolia Buch. Nov.–Jan. Abundant throughout.
—— *repens* Forst. Nov.–Dec. Lake-side, Eyre Mountains.

SOLANACEAE.

Solanum aviculare Forst. Dec.–Mar. Rare; probably introduced from Otago.
—— *nigrum* Linn. Gentle Annie, Kawarau Gorge.

SCROPHULARIACEAE.

Calceolaria repens Hook. f. Dec.–Feb. Oreti River Mouth.
Mazus radicans Cheeseman. Nov.–Feb. Moderately common.
Gratiola peruviana Linn. Nov.–Feb. Lake Hauroko, Lake Te Anau.
Glossostigma elatinoides Benth. Dec.–Feb. Damp ground and marshes. Fairly common.
—— *submersum* Petrie. Jan. Oreti River, Otatara.
Limosella tenuifolium Nutt. Dec.–Feb. Riverton Beach, Fortrose, sand-dunes.
Veronica salicifolia Forst. Dec.–Mar. Common throughout, except Stewart Island.
—— *amabilis* Cheeseman. Jan. Back of Bluff Hill, Preservation Inlet, Stewart Island (Port William, Paterson Inlet), West Coast Sounds.
—— *leiophylla* Cheeseman. Dec.–Feb. Mataura Valley below Rarawa.
—— *Menziesii* Benth. Dec.–Feb. Dusky Bay.
—— *elliptica* Forst. Dec.–Feb. Common around coast of Foveaux Strait and Stewart Island, Longwoods.
—— *Matthewsii* Cheeseman. Milford Sound, Humboldt Mountains.
—— *subalpina* Cockayne. Dec.–Mar. Common on all western mountains.
—— *Cockayniana* Cheeseman. Dec.–Feb. Clinton Valley, Humboldt Mountains, Mount Earnslaw.
—— *obovata* Kirk. Mount Earnslaw.
—— *buxifolia* Benth. Jan.–Mar. Common on all mountain-ranges.
—— —— var. *prostrata* Cockayne. Longwood Range, Mounts Cleughearn and Burns, Mount Anglem.
—— —— var. *odora* Kirk. Codfish Island, Stewart Island (Mason Bay and Pegasus).
—— *pinguifolia* Hook. f. Dec.–Jan. Burnett Peak, Wakatipu.
—— *Buchanani* Hook. f. Dec.–Feb. Mount Alta, Ben Lomond, Burnett Peak; common on most mountains, except wettest districts.

Veronica pimeleoides Hook. f. Nov.–Jan. Queenstown, Kawarau Gorge.
—— *Gilliesiana* Kirk. Dec.–Mar. Mount Alta.
—— *quadrifaria* Kirk. Dec.–Mar. Mount Alta.
—— *Hectori* Hook. f. Jan.–Mar. Hector Mountains, Mount Earnslaw, Princess Range, Mount Humboldt, Mount Cleughearn.
—— *Armstrongii* Kirk var. *annulata* Petrie. Dec.–Feb. Takitimus.
—— *Laingii* Cockayne. Jan. Mount Anglem, Clinton Saddle.
—— *propinqua* Cheeseman. Dec.–Feb. Mount Bonpland, Eyre Mountains.
—— *cupressoides* Hook. f. Dec.–Feb. Lake district.
—— *epacridea* Hook. f. Mount Roy, Lake Wanaka.
—— *Petriei* Kirk. Takitimus, Mount Bonpland, Bold Peak, Kinloch.
—— *dasyphylla* Kirk. Ben Lomond, Cecil Peak, Mount Roy.
—— *uniflora* Kirk. Hector's Col, Mount Aspiring, East Dome.
—— *macrantha* Hook. f. Jan.–Feb. Common on all western mountains.
—— *erecta* Buch. Mount Bonpland.
—— *ciliolata* Hook. f. Jan.–Feb. Mount Alta, Hector's Col, Mount Cleughearn.
—— *linifolia* Hook. f. Dec.–Jan. Lake Wanaka mountains, near Arrowtown, Eyre Mountains.
—— *catarractae* Forst. Nov.–Jan. South-west Sounds and western mountain valleys.
—— *Lyallii* Hook. f. Nov.–Mar. Blackmount, Mataura, Nokomai, Eyre Mountains, Takitimus, head of Lochy River.
—— *Bidwillii* Hook. f. Nov.–Feb. Takitimus, Eyre Mountains, Burnett Peak.
—— *Thomsoni* Cheeseman. Dec.–Feb. Mount Alta, Eyre Mountains.
—— *Willcoxii* Petrie sp. nov. ined. Routeburn.
—— *monticola* Hook. f. Common on western mountains.
—— *prorepens* Petrie sp. nov. Mount Earnslaw, Burnett Peak.
Ourisia macrocarpa Hook. f. Nov.–Jan. Clinton Valley, south-west coast generally.
—— *macrophylla* Hook. Nov.–Jan. Ben Lomond, Lake Hauroko, Takitimus, Stewart Island mountains.
—— *sessilifolia* Hook. f. Dec.–Feb. Mount Bonpland, Princess Range, Burnett Peak, Mount Cleughearn, Mount Anglem.
—— *Cockayniana* Petrie. Dec.–Jan. Cosmos Peak, Lake Wakatipu, Lake Harris Saddle.
—— *caespitosa* Hook. f. Dec.–Feb. Takitimus, Clinton Saddle, Ben Lomond, Princess Range, Stewart Island (Mount Anglem).
—— *prorepens* Petrie. Feb. The Hump, Mount Bonpland, Eyre Mountains, Routeburn, Cuthbert and Burnett Peaks, Stewart Island.
—— *modesta* Diels. Stewart Island (Rakeahua Valley).
—— *glandulosa* Hook. f. Nov.–Jan. Ben Lomond, Mount Alta, Mount Cardrona, Eyre Mountains.
Euphrasia zealandica Wettst. Dec.–Mar. Takitimus, Blackmount, Mossburn, Eyre Mountains.
—— *Dyeri* Wettst. Stewart Island (Table Hill).
—— *repens* Hook. f. Feb.–Mar. Ocean Beach, Bluff, Fortrose, Oreti Mount, Riverton Beach.
—— *umbellata* Petrie. Jan.–Feb. Oreti River, Otatara.
—— *australis* Petrie. Feb. Princess Range, Clinton Saddle, Lake Harris.
—— *Crosby-Smithii* Petrie sp. nov. ined. Jan.–Feb. Mount Cleughearn.
—— *integrifolia* Petrie sp. nov. ined. Jan.–Feb. Mount Cleughearn.

LENTIBULARIACEAE.

Utricularia monanthos Hook. f. Dec.–Feb. Common on wet ground.

MYOPORACEAE.

Myoporum laetum Forst. Oct.–Jan. Bluff and Stewart Island; said to have been introduced from Otago.

LABIATAE.

Mentha Cunninghamii Benth. Nov.–Mar. Common, sea-level to 3,000 ft.

PLANTAGINACEAE.

Plantago Raoulii Dec. Nov.–April. Common along the coast.
—— *spathulata* Hook. f. Dec.–Mar. Waikawa, Bluff (Ward Parade); fairly common
—— *Brownii* Rapin. Dec.–Feb. Common, Fortrose to Bluff and Stewart Island; abundant in mountain bogs.
—— *triandra* Bergg. var. *Hamiltonii* Kirk. Dec.–Mar. Fortrose, Bluff, Mount Cleughearn, Stewart Island (Table Hill).

ILLECEBRACEAE.

Scleranthus biflorus Hook. f. Jan.–Feb. Fairly common.

CHENOPODIACEAE.

Chenopodium glaucum Linn. Jan.–Feb. Beaches above high-water mark.
—— *detestans* Kirk. Jan.–Feb. Lake district.
Atriplex Billardieri Hook. f. Jan.–April. Paterson Inlet, Fortrose, Riverton Beach.
—— *Buchanani* Kirk. Jan.–Feb. Centre Island, Oreti Mouth.
Salicornia australis Sol. Dec.–April. Abundant along shore.
Suaeda maritima Forskal. Dec.–Mar. Common on salt marshes.

POLYGONACEAE.

Polygonum aviculare Linn. Nov.–Mar. Bluff Hill.
Rumex flexuosus Sol. Dec.–Mar. Abundant throughout.
—— *neglectus* Kirk. Nov.–Mar. Common along rocky shores.
Muehlenbeckia australis Meissn. Dec.–April. Common on Centre Island; not common on Stewart Island.
—— *complexa* Meissn. Dec.–April. Abundant on outskirts of forests.
—— *axillaris* Walp. Jan.–Feb. Takitimus, The Hump, Eyre Mountains, and abundant on stony river-beds.

CHLORANTHACEAE.

Ascarina lucida Hook. f. Sept.–Nov. Preservation Inlet, Stewart Island.

THYMELAEACEAE.

Pimelea arenaria A. Cunn. Dec.–Mar. Sand-dunes; not very common.
—— *Gnidia* Willd. Dec.–Jan. Dusky Bay, foot of Burnett Peak.
—— *Crosby-Smithiana* Petrie. Dec.–Jan. The Hump.

Pimelea laevigata Gaertn. Oct.–Mar. Abundant on dry virgin land.
—— —— var. *alpina*. Oct.–Mar. The Hump.
—— *Lyallii* Hook. f. Dec.–Mar. Sand-dunes, Fortrose, Mounts Cleughearn and Burns, Stewart Island.
Drapetes Dieffenbachii Hook. f. Dec.–Mar. Common on most mountains; sea-level, Awarua Plains and Paterson Inlet.
—— *Lyallii* Hook. f. Humboldt and Hector Mountains, Eyre Mountains, Mounts Burns and Cleughearn.

Loranthaceae.

Loranthus micranthus Hook. f. Nov.–Dec. Fairly common except Stewart Island.
Elytranthe tetrapetala Engl. Oct.–Nov. Common throughout.
—— *Colensoi* Hook. f. Nov.–Dec. Throughout western forests.
—— *flavida* Hook. f. Dec.–Feb. Queenstown, Mount Cleughearn forest.
Tupeia antarctica Cham. & Schl. Nov.–Dec. Waihopai, Seaward Bush, Winton, and throughout.
Korthalsella Lindsayi Oliver. Oct.–Feb. Winton, Seaward Bush, Greenhills.

Euphorbiaceae.

Euphorbia glauca Forst. Nov.–Feb. Stewart Island.

Urticaceae.

Paratrophis heterophylla Blume. Jan.–Feb. Hokonuis.
Urtica ferox Forst. Sept.–Dec. Hokonuis, Mount Sunnyside, Waiau.
—— *australis* Hook. f. Jan.–Mar. Dog and Centre Islands.
—— *incisa* Poir. Nov.–Mar. Scattered throughout forests.
—— —— var. *linearifolia* Hook. f. Humboldt Mountains.

Fagaceae.

Nothofagus Menziesii Hook. f. Dec.–Jan. Plentiful in south-western districts.
—— *fusca* Hook. f. Nov.–Dec. Western district thoughout, but local.
—— *Blairii* Kirk. Wakatipu, Dart Valley, Martin's Bay.
—— *Solandri* Hook. f. Nov.–Dec. Common in western district, Eyre Mountains.
—— *cliffortioides* Hook. f. Dec.–Jan. Common in western district, Eyre Mountains.

Pinaceae.

Libocedrus Bidwillii Hook. f. Lilburn, Te Anau.

Taxaceae.

Podocarpus totara D. Don. Very local and rare.
—— *Hallii* Kirk. Common.
—— *ferrugineus* D. Don. Throughout, common.
—— *spicatus* R. Br. Plentiful, but local.

Podocarpus dacrydioides A. Rich. Common.
—— *nivalis* Hook. Eyre Mountains, mountains of west and north-west, Mount Arnold, Clinton Saddle.
Dacrydium biforme Pilger. Stewart Island (Mount Anglem, Port Pegasus), Lilburn.
—— *Bidwillii* Hook. f. General in subalpine forests.
—— *cupressinum* Sol. Abundant throughout.
—— *intermedium* Kirk. Western forests and Stewart Island.
—— *laxifolium* Hook. Takitimus, Longwoods, Princess Range, Waikawa (Curio Bay), Stewart Island.
Phyllocladus trichomanoides D. Don. Rare.
—— *alpinus* Carr. Lilburn, Princess Range, and general.

ORCHIDACEAE.

Dendrobium Cunninghamii Lindl. Greenhills; common, Stewart Island.
Earina mucronata Lindl. Nov.–Feb. Common throughout virgin forests.
—— *suaveolens* Lindl. Feb.–Mar. Common throughout virgin forests.
Sarchochilus adversus Hook. f. Nov.–Dec. Tokonui, Stewart Island.
Thelymitra longifolia Forst. Dec.–Jan. Bluff (Kirk).
—— *pachyphylla* Cheeseman. Dec.–Jan. Abundant on damp ground.
—— *uniflora* Hook. f. Dec.–Jan. Abundant on damp ground.
Microtis porrifolia R. Br. Nov.–Jan. Abundant throughout fields.
Prasophyllum Colensoi Hook. f. Dec.–Feb. Common up to 4,000 ft.
Pterostylis Banksii R. Br. Nov.–Jan. Common in all shady forests.
—— *australis* Hook. f. Nov.–Jan. Common in all shady forests.
—— *graminea* Hook. f. Oct.–Nov. Hump forest, Stewart Island.
Lyperanthus antarcticus Hook. f. Dec.–Feb. Lower peak of The Hump, Longwoods, Stewart Island.
Caladenia minor Hook. f. Dec.–Jan. Golden Bay Track, Stewart Island.
—— *Lyallii* Hook. f. Dec.–Jan. Greenhills, Woodend, Stewart Island.
—— *bifolia* Hook. f. Dec.–Jan. Bluff, Woodend, Stewart Island.
Chiloglottis cornuta Hook. f. Nov.–Jan. Rather rare.
Adenochilus gracilis Hook. f. Nov.–Jan. Lake Hauroko forests, west of Lake Te Anau.
Corysanthes rivularis Hook. f. Oct.–Dec. Lake Hauroko forest, Stewart Island.
—— *rotundifolia* Hook. f. Oct.–Dec. Common in shady places.
—— *triloba* Hook. f. Sept. Bluff Hill, Longwood forest, Stewart Island.
—— *macrantha* Hook. f. Nov.–Feb. Lake Hauroko forest, Stewart Island.
—— *oblonga* Hook. f. Oct.–Nov. Stewart Island.
Gastrodia Cunninghamii Hook. f. Nov.–Jan. East and west sides of Longwoods, Greenhills, Lochy River valley, Stewart Island; rare.

IRIDACEAE.

Libertia ixioides Spreng. Nov.–Jan. Common throughout.
—— *grandiflora* Sweet. Nov.–Dec. Tokonui, Waianiwa.
—— *pulchella* Spreng Nov.–Jan. The Hump, Takitimus, Longwoods, Stewart Island.

Liliaceae.

Rhipogonum scandens Forst. Nov.–Jan. Thinly distributed throughout; rare at Seaward Bush, common at Stewart Island.

Luzuriaga marginata Banks & Sol. Dec.–Feb. Common throughout virgin forests.

Cordyline australis Hook. f. Nov.–Jan. Common throughout, rare at Stewart Island.

—— *Banksii* Hook. f. Nov.–Dec. Dusky Sound.

—— *indivisa* Steud. Dec.–Jan. Dusky Sound.

Astelia linearis Hook. f. Nov.–Jan. Subalpine bogs throughout.

—— *Petriei* Cockayne. Nov.–Dec. Lake Harris, Clinton Saddle.

—— *nervosa* Banks & Sol. Nov.–Dec. Common throughout in lowland forest.

—— *montana* Cockayne. Nov.–Dec. Longwoods, Takitimus, Princess Range, western mountains generally, sea-level around Invercargill.

—— *Petriei* Cockayne. Lake Harris Saddle, Clinton Valley.

—— *subulata* Cheeseman. Stewart Island (near Fraser Peaks).

Dianella intermedia Endl. Nov.–Dec. Wakatipu district; not known around Foveaux Strait.

Phormium tenax Forst. Nov.–Jan. Abundant throughout.

—— *Cookianum* Le Jolis. Dec.–Jan. Western mountain regions, Eyre Mountains, Stewart Island (Port Pegasus).

Bulbinella Gibbsii Cockayne. Nov.–Jan. Takitimus, all Stewart Island mountains.

—— *Hookeri* Benth. Nov.–Jan. On wet ground, both lowland and mountains.

Arthropodium candidum Raoul. Lake Wakatipu, Longwoods, The Hump, forest.

Herpolirion novae-zealandiae Hook. f. Dec.–Jan. On damp ground throughout.

Juncaceae.

Rostkovia gracilis Hook. f. Dec.–Feb. Hector Mountains.

Juncus antarcticus Hook. f. Blackmount, Bluff, Mount Cleughearn, Stewart Island.

—— *pallidus* R. Br. Dec.–Feb. Stewart Island.

—— *pauciflorus* R. Br. Dec.–Feb. Stewart Island.

—— *vaginatus* R. Br. Dec.–Feb. Lake district.

—— *effusus* Linn. Dec.–Feb. Common everywhere.

—— *planifolius* R. Br. Nov.–Jan. Bluff, Blackmount; common.

—— *lampocarpus* Ehr. Nov.–Feb. Takitimus; abundant.

—— *novae-zealandiae* Hook. f. Jan.–Mar. Bluff, Clinton Valley; common on Stewart Island.

—— *bufonius* Linn. Jan.–Feb. Common.

Luzula pumila Hook. f. Jan.–Feb. Mount Cardrona.

—— *Colensoi* Hook. f. Jan.–Feb. Longwood Range.

—— *micrantha* Buchen. Dec.–Feb. Mount Cardrona.

—— *Cheesemanii* Buchen. Jan.–Feb. Mount Cardrona.

—— *racemosa* Desv. var. *Traversii* Buchen. Dec.–Feb. Ben Lomond, Lake Wakatipu, Mount Earnslaw.

—— *campestris* D.C. Dec.–Feb. Abundant throughout.

PANDANEAE.

Freycinetta Banksii A. Cunn. Sept.–Nov. Milford Sound.

TYPHACEAE.

Typha angustifolia Linn. Dec.–Mar. Common.

LEMNACEAE.

Lemna minor Linn. Common.

NAIADACEAE.

Triglochin striatum Ruiz & Pav. Nov.–Jan. Bluff, Fortrose, Stewart Island.
Potamogeton natans Linn. Dec.–Mar. Common.
—— *Cheesemanii* A. Benn. Dec.–Mar. Common.
—— *polygonifolius* Pourr. Jan.–April. Common.
Ruppia maritima Linn. Dec.–April. Abundant in brackish water.
Zostera nana Roth. Jan. Common in salt water.

CENTROLEPIDACEAE.

Centrolepis strigosa Roem. & Schult. Dec.–Jan. Bluff Hill.
—— *pallida* Cheeseman. Dec.–Mar. Common in mountain bogs.
—— *viridis* Kirk. Jan.–Mar. Bluff, and common in mountain bogs.
—— *minima* Kirk. Jan.–Mar. Bluff Hill, Te Anau.
Gaimardia setaceae Hook. Dec.–Mar. All subalpine bogs.

RESTIONACEAE.

Leptocarpus simplex A. Rich. Oct.–Jan. Common around Invercargill and gravelly shores of Lakes Manapouri and Te Anau and swamps of Stewart Island.
Hypolaena laterifolia Benth. Abundant.

CYPERACEAE.

Eleocharis acicularis R. Br. Dec.–Mar. Lake Te Anau.
—— *acuta* R. Br. Dec.–Mar. The Hump, Princess Range, Stewart Island; common in shallow streams.
—— *sphacelata* R. Br. Stewart Island (Freshwater Valley and Mason Bay).
—— *Cunninghamii* Boeck. Bluff, Stewart Island, and common in shallow streams.
Scripus aucklandicus Boeck. Dec.–Mar. Abundant in mountain bogs and on coast.
—— *cernuus* Vahl. Dec.–Feb. Common.
—— *antarcticus* Linn. Dec.–Mar. Abundant on coast.
—— *inundatus* Poir. Dec.–Mar. The Hump, Stewart Island.
—— *sulcatus* Thouars. Dec.–Mar. Stewart Island.
—— *nodosus* Rottb. Nov.–Feb. Common on Stewart Island.
—— *frondosus* Banks & Sol. Nov.–Feb. Common on sand-dunes.
—— *americanus* Pers. Dec.–Mar. Common in salt-water swamps.
Carpha alpina R. Br. Dec.–Mar. Abundant on hilly ground and sea-level at Bluff and Stewart Island.

Schoenus pauciflorus Hook. f. Dec.–Mar. All upland bogs.
—— *axillaris* Poir. Dec.–Mar. Bluff, Blackmount, Stewart Island.
—— *apogon* Roem. & Schult. Dec.–Mar. Stewart Island.
—— *nitens* Poir. Dec.–Mar. Fortrose, Stewart Island.
Cladium glomeratum R. Br. Dec.–Feb. Swamps, Stewart Island.
—— *Gunnii* Hook. f. Jan.–Feb. Bogs, Bluff Hill; Stewart Island.
—— *Vauthiera* Clarke. Dec.–Jan. Bogs; common on Stewart Island.
Gahnia procera Forst. Dec.–Jan. Common in western-beach forest, Stewart Island.
Oreobolus pumilio R. Br. Jan.–Feb. Common on all subalpine bogs.
—— —— var. *pectinatus* C. B. Clarke. Jan.–Feb. Eyre Mountains, Fortrose, Bluff Hill, Stewart Island.
—— *strictus* Bergg. Jan. Bluff (Petrie), Hector Mountains, Stewart Island.
Uncinia campacta R. Br. Dec.–Feb. Common on alpine meadows.
—— *caespitosa* Boott. Dec.–Jan. Common throughout.
—— *leptostachya* Raoul. Dec.–Feb. Fairly common throughout.
—— *riparia* R. Br. Mount Cleughearn, Stewart Island.
—— *rubra* Boott. Bluff Hill, Takitimus, Fortrose, Stewart Island.
—— *rupestris* Raoul var. *capillacea* Kukn. Dec.–Jan. Stewart Island.
—— *rigida* Petrie. Dec.–Feb. Stewart Island.
—— *filiformis* Boott. Dec.–Feb. Common in forests of west.
—— *pedicellata* Kukn. Ruapuke, common in forests in Stewart Island.
—— *macrolepis Sinclairii* Don. Dec.–Feb. Hector Mountains, Dart Valley, Mount Cardrona.
—— *tenella* R. Br. Jan.–Feb. Princess Range, Clinton Valley, Routeburn.
—— *uncinata* Kukn. (*australis*). Dec.–Feb. Stewart Island, Clinton Saddle.
—— *purpurata* Petrie. Dec.–Feb. All mountain districts.
—— *fusco-vaginata* Kukn. Mount Hector, Mount Cardrona.
Carex pyrenaica Wahl. Dec.–Mar. Higher mountains of Lake district.
—— *acicularis* Boott. Dec.–Mar. Lake Harris, Old Man Range.
—— *pterocarpa* Petrie. Hector Mountains, Mount Pisa (Petrie).
—— *Kirkii* Petrie. Jan.–Mar. Hector Mountains.
—— *Muelleri* Petrie. Dec.–Mar. Mount Cardrona, Nevis Valley.
—— *appressa* R. Br. Nov.–Feb. Common in wet ground along coast.
—— *virgata* Sol. Dec.–Feb. Common in swamps.
—— *secta* Boott. Dec.–Feb. Common in most swamps.
—— *ternaria* Forst. Dec.–Feb. Common throughout.
—— *lagopina* Wahl. Lake Wakatipu, Mount Hector.
—— *Gaudichaudiana* Kukn. Clinton Valley.
—— *Sinclairii* Boott. Dec.–Feb. Routeburn Valley.
—— *Raoullii* Boott. Dec.–Feb. Mount Cardrona, Wakatipu, Wanaka.
—— *wakatipu* Petrie. Dec.–Feb. Ben Lomond, Mount Hector, Mount Cardrona.
—— *lucida* Boott. Nov.–Jan. Common throughout.
—— *testacea* Sol. Nov.–Feb. Stewart Island, common throughout.
—— *Buchanani* Bergg. Dec.–Jan. Common on edges of river-gravel.
—— *rubicunda* Petrie. Jan.–Feb. Te Anau.
—— *uncifolia* Cheeseman. Dec.–Feb. Hector Mountains, Lake Harris.
—— *Petriei* Cheeseman. Dec.–Feb. Mountain valleys, Lake district.
—— *comans* Bergg. Dec.–Feb. Bluff, generally around Invercargill, Centre Island, Stewart Island.

Carex plesiostachys Clarke. Nov.–Jan. Milford Sound.
—— *litorosa* Bailey. Nov.–Jan. Confined to salt swamps, Stewart Island.
—— *dissita* Sol. Nov.–Feb. Common in forests, Bluff Hill, Mount Cleughearn, Stewart Island (Mount Anglem).
—— *Solandri* Boott. Nov.–Feb. Stewart Island.
—— *longiculmis* Petrie. Dec.–Feb. Stewart Island (Glory Cove).
—— *trifida* Cav. Dec.–Feb. Abundant on coast.
—— *pumila* Thunb. Nov.–Jan. Common in hollows of sandhills.
—— *breviculmis* R. Br. Oct.–Mar. Bluff Hill; common.
—— *Cockayniana* Kukn. Nov.–Feb. Clinton Valley.
—— *Oederi* Retz. var. *cataractae* Kukn. Nov.–Jan. Clinton Valley.

GRAMINEAE.

Microlaena Colensoi (Hook. f.) Petrie. Clinton Saddle, Takitimus, Longwood.
—— *Thomsoni* Petrie. Jan.–Feb. Longwood Range, Stewart Island (Port Pegasus, Rakeahua); common on open ground.
—— *avenacea* Hook. f. Dec.–Jan. Abundant in all forests; common on Stewart Island.
—— *stipoides* R. Br. Bluff, Blackmount, Stewart Island.
Hierochloe redolens R. Br. Dec.–Feb. Common on most virgin lands.
—— *Fraseri* Hook. f. Bluff, Takitimus, Cuthbert Peak, Stewart Island.
Alopecurus geniculatus Linn. Jan.–Feb. Fairly common in marshy places.
Agrostis magellanicus Linn. Jan. Clinton Valley.
—— *Dyeri* Petrie. Dec.–Jan. Fairly common uplands throughout.
—— *Petriei* Hack. Jan. Lake Wakatipu, Nevis Valley.
—— *muscosa* T. Kirk. Jan. Bluff (Ward Parade).
—— *Muelleri* Benth. Jan.–Feb. Takitimus, Hector and Cardrona Mountains, Mount Cleughearn.
—— *parviflora* R. Br. Jan.–Feb. Hokonuis.
—— *tenella* Petrie. Jan.–Feb. Lake Wakatipu.
Deyeuxia setifolia Hook. f. Jan.–Feb. Common on all mountains.
—— *avenoides* Buch. Dec.–Feb. Common on all mountains.
—— *Forsteri* Kunth. Dec.–Feb. Common everywhere.
—— —— var. *humilior* Hack. Princess Range, Lake Te Anau.
—— —— var. *littoralis* Hack. Fairly common on coast.
—— —— var. *Lyallii* Hack. Milford Sound, Princess Range.
—— *Billardieri* Kunth Dec.–Feb. Common on all sandhills.
—— *pilosa* (A. Rich.) Cockayne. Jan.–Feb. Clinton Saddle, Mount Cleughearn.
—— *quadriseta* Benth. Jan.–Feb. Bluff, Stewart Island (Rakeahua).
Dichelachne crinita Hook. f. Dec.–Jan. Fairly common.
—— *sciurea* Hook. f. Jan.–Feb. Bluff Hill.
Deschampsia caespitosa Beauv. Jan.–Feb. Fairly common.
—— *Chapmani* Petrie. Jan. Common western mountains.
—— *pusilla* Petrie. Jan. Hector and Humboldt Mountains.
—— *novae-zealandiae* Petrie. Jan. Hector Mountains, Lake Te Anau.
—— *tenella* Petrie. Jan. Clinton Saddle.
Trisetum antarcticum Trin. Common on both lowland and mountains.
—— *Youngii* Hook. f. Jan. Takitimus and other subalpine localities.
—— *Cheesemanii* Hack. Jan. Routeburn Valley Humboldt and Hector Mountains.
Danthonia Cunninghamii Hook. f. Feb.–April. Fairly common inland.

Danthonia ovata Buch. Feb.–Mar. Mount Eglinton.
—— *teretifolia* Petrie sp. nov. (*vide ante*, p. 36). Longwood and Princess Ranges.
—— *Raoullii* Steud. Jan.–Mar. Common on both lowlands and mountains.
—— *crassiuscula* Kirk. Jan.–Feb. Longwood Range, Clinton Saddle, Eyre Mountains, Stewart Island (Mount Anglem).
—— *pungens* Cheeseman. Feb. All mountains at Stewart Island.
—— *planifolia* Petrie. Clinton Saddle.
—— *Raoulii* Steud. var. *flavescens* Hack. Abundant on all high mountains.
—— *pilosa* R. Br. Jan.–Feb. Abundant on lowlands and mountains.
—— —— var. *racemosa*. Buch. Jan. Abundant throughout.
—— *semiannularis* R. Br. Jan.-Feb. Common.
—— —— var. *setifolia* Hook. f. Jan.–Feb. Common on high mountains.
—— *Buchanani* Hook. f. Lake Te Anau, Pembroke, Tukituki Valley, Mount Cleughearn.
Arundo conspicua Forst. Jan.–Mar. Common throughout.
—— *fulvida* Buch. Riverton, Mataura (Petrie).
Triodia Thomsoni Petrie. Jan. Not uncommon on drier virgin flats.
—— *pumila* Hack. Jan. Queenstown.
—— *australis* Petrie. Jan. Mount Cardrona, Cuthbert Peak.
Koeleria Kurtzii Hack. Jan.–Feb. Common on dry upland stations.
Poa foliosa Hook. f. Dec.–Jan. Herekopere Island, Solander Islands.
—— *novae-zealandiae* Hack. Jan.–Feb. Takitimus and Hector Mountains, Clinton Valley.
—— *Poppelwelli* Petrie sp. nov. (*vide ante*, p. 38). Herekopere Island.
—— *pusilla* Bergg. Jan.–Feb. Dog Island, Stewart Island, valleys of western mountains.
—— *caespitosa* Forst. Jan.–Feb. Common throughout.
—— *Colensoi* Hook. f. Jan.–Feb. Common on mountains.
—— *Kirkii* Buch. Jan.–Feb. Hokonuis, Longwood Range, Cuthbert Peak.
—— *imbecilla* Forst. Jan. Not uncommon.
—— *Astoni* Petrie. Nov.–Feb. Common around coast and Stewart Island.
—— *exigua* Hook. f. Hector, Cardrona, and Humboldt Mountains.
—— *maniototo* Petrie. Lake Wanaka.
—— *oraria* Petrie. Deep Cove (Aston).
—— *Guthrie-Smithiana* Petrie sp. nov. ined. Jan. Herekopere Island.
—— *seticulmis* Petrie. Jan.–Feb. Common, Bluff, Takitimus.
—— *antipoda* Petrie. Herekopere Island.
Atropis novae-zealandiae Hack. Jan.–Feb. Ocean Beach, Stewart Island (near Half-moon Bay).
Festuca littoralis Labill. Nov.–Feb. Abundant on sand-dunes.
—— *ovina* Linn. Common on the uplands.
—— *rubra* Linn. Jan.–Feb. On shaded mountain-slopes.
—— —— var. *Matthewsii* Petrie. Mount Bonpland.
Agropyron scabrum R. Br. Jan.–Feb. Upland pasture ; fairly common.
Asperella laevis Petrie. Jan.–Feb. Matukituki Valley, Milford, Waikawa.
—— *gracilis* T. Kirk. Stewart Island.

Filicies.

Hymenophyllum rarum R. Br. End Peak, Stewart Island.
—— *polyanthos* Swartz. Common throughout.
—— *villosum* Col. Greenhills, Lake Hauroko, Stewart Island (Mount Anglem).

Hymenophyllum australe Willd. Very rare, Stewart Island.
—— *atrovirens* Col. Head of Lake Wakatipu.
—— *pulcherrimum* Col. Head of Lake Hauroko and west-coast forests, Stewart Island.
—— *dilatatum* Swartz. Common throughout.
—— *demissum* Swartz. Common throughout.
—— *scabrum* A. Rich. Generally common.
—— *flabellatum* Labill. Head of Lake Hauroko; common throughout.
—— *rufescens* Kirk. Head of Lake Hauroko, Stewart Island (Rakeahua).
—— *Cheesemanii* Bak. Rare, Stewart Island.
—— *minimum* A. Rich. Stewart Island.
—— *tunbridgense* Smith. Common throughout.
—— *bivalve* Swartz. Common throughout.
—— *multifidum* Swartz. Common throughout.
—— *ferrugineum* Colla. Common throughout.
—— *peltatum* Poir. Stewart Island.
Trichomanes reniforme Forst. Common in western forests, Greenhills, Oreti Mouth, Stewart Island (Paterson Inlet, Kaipipi, and Half-moon Bay).
—— *Lyallii.* On inclined trunks of *Metrosideros lucida*, Mount Anglem.
—— *venosum* R. Br. Common throughout, on *Dicksonia.*
—— *strictum* Menzies. Stewart Island; not uncommon.

CYATHEACEAE.

Cyathea medullaris Swartz Princess Range (End Peak), Hump forest, Stewart Island.
Hemitelia Smithii Hook. Abundant throughout.
Alsophila Colensoi Hook. f. South Riverton forest, Mount Anglem, Table Hill, Thomson Range, south coast.
Dicksonia squarrosa Swartz. Abundant throughout.
—— *fibrosa* Col. Abundant.
Davallia Forsteri Carruthers. Dusky Bay
Leptolepia novae-zealandiae Col. Not uncommon throughout.
Cystopteris fragilis Bernh. Rock-crevices, head of River Lochy.
Lindsaya linearis Swartz Woodend, Bluff, Stewart Island.
Adiantum affine Willd. Greenhills, Stewart Island.
Hypolepis tenuifolium Bernh. Abundant throughout.
Cheilanthes tenuifolia Swartz. Lake Wakatipu, Lake Wanaka.
—— *Sieberi* Kunze. Lake Wakatipu.
Pellaea rotundifolia Hook. Seaward Bush, Mimihau; fairly common.
Pteris aquilina Linn. var *esculenta* Forst. Common throughout.
—— *scaberula* A. Rich. Abundant throughout.
—— *incisa* Thunb. Abundant throughout.
Blechnum Patersoni Spreng. Hill forests at Longwoods, Riverton, Stewart Island (Mount Anglem).
—— *discolor* Willd. Abundant everywhere.
—— *vulcanica* Blume. Common, but local.
—— *lanceolata* Spreng. Fairly common throughout.
—— *Banksii* Hook. f Common on coast.
—— *dura* Moore. Common on coast.
—— *capensis* Willd. Very abundant.
—— *penna marina* Kulm. Eyre Mountains.

Blechnum nigra Col. Milford Sound; rather scarce at Stewart Island.
—— *fluviatile* Spreng. Common in all forests.
Asplenium adiantoides C. Chr. Fairly common at Stewart Island; rare on mainland.
—— *obtusatum* Forst. Common on coast.
—— *lucidum* Forst. Common.
—— *scleroprium* Homb. & Jacq. Local, Stewart Island.
—— *Hookerianum* Col. Very rare.
—— *bulbiferum* Forst. Common throughout.
—— *flaccidum* Forst. Common throughout.
—— *Richardi* Hook. f. Hokonuis, Clinton Saddle.
Polystichum Richardi Hook. Fairly common.
—— *vestitum* Forst. Abundant.
—— *adiantiforme* J. Sm. Common in forests.
—— *cystostegia* Hook. f. Eyre Mountains, Mount Cleughearn, Burnett Peak.
Nephrodium glabellum A. Cunn. Local.
—— *hispidum* Hook. Common throughout.
Polypodium punctatum Thunb. Common throughout.
—— *pennigerum* Forst. Local.
—— *serpens* Forst. Fairly common throughout.
—— *pustulatum* Forst. Rare.
—— *Billardieri* R. Br. Extremely abundant.
—— —— var. *rigidum* (Homb. & Jacq.) Cockayne. Stewart Island (Mount Anglem).
—— *pumulum* Cockayne. Stewart Island, highest summits.
—— *grammitidis* R. Br. Common on tree-trunks.
—— *diversifolium* Willd. Abundant on ground.
—— *australe* Mett. Common throughout; Stewart Island (Kirk).
Gleichenia circinata R. Br. Somewhat local.
—— *dicarpa* R. Br. Common throughout, on bogs.
—— *alpina* Hook. f. Alpine bogs and Stewart Island.
—— *Cunninghamii* Hook. Fairly common.
Schizaea fistulosa Labill. Stewart Island; common.
Todea hymenophylloides A. Rich. Not very common, and local.
—— *superba* Col. Distributed through all damp forests, but not very plentiful; common on Stewart Island.
Ophioglossum vulgatum Linn. Tokonui, Waiau River terrace.
Botrychium ternatum Swartz. Very local and rare.
Azolla rubra R. Br. Ruapuke, Wyndham.
Lycopodium Selago Linn. Scattered thinly through forests.
—— *varium* R. Br. Takitimus, Mount Anglem.
—— *Billardieri* Spreng. Common throughout.
—— *ramulosum* Kirk. Common.
—— *fastigiatum* R. Br. Princess Mountains (End Peak), The Hump, Mount Cleughearn, Stewart Island.
—— *scariosum* Forst. Woodend, Eyre Mountains, Stewart Island.
—— *volubile* Forst. Eyre Mountains, Stewart Island.
Tmesipteris tannensis Bernh. Common throughout.

ART. XXXI.—*On a Pigment in Oysters.*

By G. H. ROBERTSON, M.Sc.

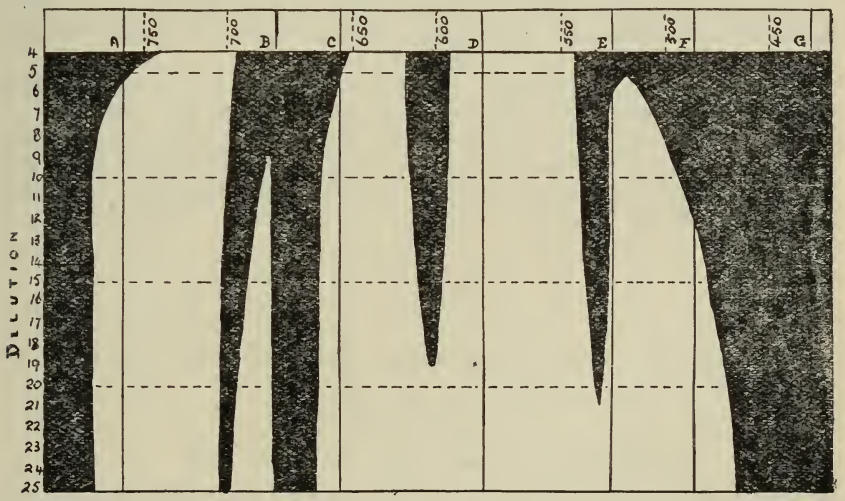
[*Read before the Otago Institute, 7th October, 1913.*]

THE existence in the Stewart Island oyster of a pigment with a distinct absorption spectrum has already been recorded by J. Malcolm.* This investigator noticed that when dried oyster was extracted with ether, chloroform, benzene, or other fat-solvent a solution was obtained which gave a single band in the red—nearer the infra-red than the characteristic methaemoglobin band. The pigment was found in all the samples examined.

The present investigation was directed towards mapping out the variation of the spectrum with dilution, and the reactions of the pigment, with a view to placing it in one of the known classes of animal pigments.

Of all solvents, the pigment was found to be most soluble in ether, and accordingly this solution was used for spectroscopic examination. The results of this examination will be seen in the accompanying figure.

At the highest concentrations obtained two bands are seen, both in the red. As the dilution increases, a band appears in the blue-green about the neighbourhood of the E line. At a slightly greater dilution the broad band



GRAPHIC REPRESENTATION OF THE VARIATION IN THE ABSORPTION SPECTRUM OF SOLUTIONS OF OYSTER PIGMENT WITH CHANGING DILUTION.

at the red end splits into two, and now over a considerable range of dilution four bands are visible. At greater dilutions the various bands disappear, as shown in the figure, which is drawn accurately to scale. The band in the red, between the B and C lines, persists long after the other bands have all been lost sight of. This is probably the band observed by Malcolm.

Chemically the pigment is characterized by its great stability. Alcoholic or alcohol-ether solutions were used, and when the addition of the reagent caused no change in the position of the bands it was presumed

* Trans. N.Z. Inst., vol. 44, 1912, p. 265.

that no change had taken place. Attempts to oxidize the pigment with potassium ferricyanide, with aqua regia, and with pure nitric acid left the pigment apparently unchanged. Reduction with ammonium sulphide and with sulphurous acid had a similar non-effect. The pigment is stable to acids—strong hydrochloric—and to alkalies, standing boiling with watery potash, but broken up by boiling with alcoholic potash.

Though these chemical results are negative on the whole, yet they serve to distinguish the pigment from all the known haemoglobin compounds.

It was considered possible that more than one pigment was present, and efforts were made to effect a separation. Extracts made with hot alcohol precipitate on cooling. Both residue and filtrate contain pigment, but with the same bands. If an ethereal extract be evaporated down almost to dryness, and then taken up with an equal amount of absolute alcohol, the same bands are seen as in the original ether solution. The residue, insoluble in the alcohol, gives in ether solution the same series of bands, and with the same relative proportion of depth. The ethereal solution of the pigment is greenish-yellow in colour, not fluorescent.

The pigments already recorded* in *Mollusca* are haemoglobin, haematin, haematoporphyrin, and biliverdin. The ready solubility in ether of the present pigment excludes all four of these; its spectrum excludes all of them except perhaps haematin, which, in acid solution, certainly has four bands, but in the following positions: 1, between C and D; 2, close to D; 3, between D and E; 4, towards F. All but the first are lost in alkaline solution of haematin.

A second series of pigments recorded in *Mollusca* are those belonging to the melanin group, to which this pigment certainly does not belong.

The solubilities of this pigment in the fat-solvents would suggest relationships to the lipochromes, a series of pigments associated with fats; but these are in general unstable, and all have but two bands, in the region between the F and G lines.

Art. XXXII.—*Some Experiments on Tutin and Tutu Poisoning.*

By John Malcolm, M.D.

[*Read before the Otago Institute, 7th October, 1913.*]

The following is a short description of some work on tutu and tutin poisoning that has occupied me at various periods since the publication of the joint paper on tutin by Dr. Fitchett and myself in the "Quarterly Journal of Experimental Physiology" (vol. 2, p. 335, 1909). In the beginning of that paper we gave the history of the previous work done on the subject, and a practically similar account is also given by Dr. Fitchett in a paper published in these Transactions (vol. 41, p. 286, 1909).

Since the publication of these papers, a paper entitled "On the Toxicology of the Tutu-plant" has been published by W. W. Ford in the "Journal of Pharmacology and Therapeutics" (vol. 2, 1910). Dr. Ford had received some tutin from Mr. Aston, Wellington, and had experimented in very

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* O. v. Fürth, Vergleichende chemische Phys. der niederen Tiere, pp. 527–33.

much the same way and with practically the same results as Dr. Fitchett and myself. He found, as we did, that tutin is extremely toxic, the lethal dose to guinea-pigs and rabbits being a few milligrams per kilogram body-weight, and that it is not readily destroyed—*e.g.*, it withstands treatment with acids, and does not lose its properties on standing. Like ourselves, he failed to produce immunity to its action. A large part of his work was done on the fate of tutin in the tissues, and his most striking assertion is that the tutin can be localized in the brain. From our experiments Fitchett and myself had come to the conclusion that tutin attacks the nerve-centres, but Ford goes further and says he is able to prove its existence in the brain as a "detoxified" body which reduces Fehling's solution after being hydrolyzed with HCl. I have repeated his experiments, following his method so far as I can gather it from his paper, but I have not succeeded in getting a positive result. The same problem had presented itself to me before I saw Ford's paper, and I had already done some of the experiments he describes—*e.g.*, I also found that brain-tissue from a recently killed animal does not diminish the toxic power of tutin (Exp. 226).

RECENT EXPERIMENTS ON THE FATE OF TUTIN IN THE BODY.

Our previous work on this point had led to no positive conclusions. We found no evidence for the existence of tutin in the urine or in the milk of rabbits. We believed we had some evidence of accumulation of the drug, as successive sublethal doses proved fatal (see Exp. 13 in Fitchett's paper), but we suggested that the facts might be explained in another way—viz., that the vital mechanisms became more and more susceptible to the action of the drug.

In considering the possible fate of a poison in the body several possibilities present themselves: (*a*) The poison may remain unchanged and become uniformly distributed throughout the tissues; (*b*) it may remain unchanged, but some tissues may have more and some less; (*c*) it may be changed into some other substance which may be uniformly or irregularly distributed. Besides these possibilities, the poison may be excreted more or less rapidly in changed or unchanged form; in the case of tutin this is unlikely, at least so far as the unchanged poison is concerned (see previous papers). Concerning the other possibilities, all that one can say at present is that experiments show that (*a*) is unlikely—*e.g.*, Exps. 238 and 240 show that the extract of relatively large amounts of muscle has no toxic effect. This fact is of considerable practical importance to sheep-farmers, for I believe it would be quite safe to feed the dogs on the meat of sheep accidentally poisoned by tutu.

Besides the muscles, I have examined the liver, blood, and brain of animals after administration of large doses—larger relatively than is likely to occur in stock spontaneously eating the tutu-plant—but I have not been able to detect any evidence of its presence in any tissue except blood and brain, and in those instances only in traces.

In examining the tissues for presence of tutin two methods presented themselves—that used by Ford, in which the tissue is examined for a reducing substance after hydrolyzing; and, secondly, the biological method, in which the toxicity of extracts of the tissue is examined. As already stated, I was unable to obtain Dr. Ford's results, and accordingly made use of the second method to a greater extent. The tissue was usually dried, care being taken that the reaction was acid; the dried material was ex-

tracted with hot alcohol, and the alcoholic extract concentrated, neutralized, and taken up with water to form a clear liquid in some cases, in others an emulsion.

Blood.—Since the practice of bleeding is universally recognized as valuable in the treatment of stock poisoned by tutu, my attention was specially drawn to this tissue. In bleeding "tutued" sheep it is a common practice to slit a vein near the eye—the blood flows down on the face, and much of it is said to be swallowed. This led me to try whether fresh blood has any influence on the toxicity of tutin. Exp. 225 shows that it has little, if any, effect. The other experiments recorded here had as their object the discovery of tutin in the blood; and the results show that shortly after the administration of large doses of tutin the blood contains some poison —either tutin itself in traces or some other toxic body arising from it or resulting from its action. The experiments in support of this are the following:—

Exp. No. 234: Rabbit, weight 2,010 grm., received 10 mlgrm. tutin intravenously. Respiration immediately became quickened; seven minutes after injection the animal began to show muscular symptoms, and at eight minutes a typical convulsion broke out. Twenty minutes after the injection, and when nearly dead, it was killed by bleeding; the blood was defibrinated, and within twenty minutes 10 c.c. of it was injected in two portions into the ear-vein of a rabbit (No. 235) weighing 1,350 grm. The animal became dazed and sleepy-looking; it sat with its eyeballs rolled up under the half-closed lids, and the respiration-rate was markedly increased. It also licked its lips repeatedly as if salivating, but within an hour it seemed to have completely recovered. These symptoms point to the presence of some tutin or an allied toxic body in the blood. If all the tutin were present in the blood as such the dose would have been 1 mlgrm., and the animal would have shown much more decided symptoms. The residue of the blood of the first rabbit was evaporated to dryness; it then weighed 7·2 grm., and therefore represented about 35 c.c. of blood = one-third of the total blood of the animal. The dried residue was treated with alcohol, and the alcoholic extract taken up with water as already described. The whole quantity was given by mouth to a kitten (No. 237). It developed some twitching of the ears, licking of its lips, and swallowing movements, &c., but recovered completely. The symptoms here are suggestive of small amounts of tutin in the blood; and on calculating the percentage present, if the tutin were uniformly distributed throughout the body, one may safely conclude that the blood had more than its due share of the poison, while, as shown above, the blood did not contain all the poison.

Exp. No. 232: Rabbit, weight 1,588 grm., received hypodermically 1·5 c.c. of 0·5 per cent. tutin = 7·5 mlgrm. The animal had severe symptoms, and was killed half an hour after the dose was administered. The brain and cord weighed 11 grm. The blood and washings of blood-vessels yielded 9·8 grm. dried material; it was calculated, therefore, that the amount of blood obtained = 43 c.c. = more than half the total blood.

Both tissues were acidified with HCl and evaporated to dryness, then both were extracted with absolute alcohol and the extract dissolved in water after removing the alcohol.

The whole of the extract of brain and cord, measuring 3 c.c., was injected into the peritoneum of a rabbit weighing 673 grm., but no symptoms of any kind followed.

The watery extract of blood obtained in the same way also measured 3 c.c. Half of it was injected intravenously into a small rabbit (weight, 671 grm.). Before the injection was finished it jerked its head backwards, and when released fell over on its back, clawed the air in a convulsive manner, and was dead in a few seconds.

The remaining half of the extract was given hypodermically to another small rabbit. During the injection the animal writhed as if in pain, later on the latter half of the body became paralysed, the respiration became very feeble, but in about half an hour it had completely recovered.

Exp. No. 233 : The blood of a normal rabbit, measuring about 30 grm., was treated in an exactly similar way to that of No. 232, and the final watery extract injected into the small rabbit that had survived (*vide supra*). No symptoms followed, and there is little doubt but that the blood in this case (232) contained some toxic body, although the symptoms produced were not those of tutin.

Other experiments bearing on this part of the subject are detailed in the protocols of experiments 199, 229, and 244; but I consider the results less conclusive here, because frogs frequently die when injected with foreign material, and the blood, at least in cats, may give reduction without being hydrolyzed, while in Exp. 244 the blood of a tutinized cat failed to give the reduction test.

These results indicate that the beneficial effects of bleeding can hardly be ascribed to the removal of the poison in the shed blood, for the tutin absorbed from ingested tutu is not likely to be present in such high concentration as in these experiments, and yet the blood in these cases had comparatively feeble toxic power although the quantities used were relatively large—certainly larger relatively than would occur in bleeding as usually practised on sheep.

Brain.—From Dr. Ford's statements one might be led to believe that practically all of a moderate dose of tutin becomes concentrated in the brain of the animal. As already stated, I was unable to confirm this by the chemical test, and the biological test, with one exception, also gave negative results. Thus in the experiment described above (No. 232) the hydrolyzed brain of the rabbit produced no effect.

In Exp. 229 the extract of brain gave no reduction after hydrolysis, but some reduction was obtained with the extract of foetal brains. This latter point requires further investigation ; a reducing body may be normally present. The result of injection of the hydrolyzed brain extract into a frog is inconclusive, because the control frog, in which the extract was treated with KOH to destroy the suspected tutin, also died.

In Exp. 240 a rabbit weighing 1,350 grm. received 10 mlgrm. tutin intravenously. The brain, with the spinal cord, weighing 10·3 grm., was extracted with alcohol, and the extract was dissolved in water. One-third of this solution was injected into a cat without effect. The material used here was not hydrolyzed, and the absence of symptoms corresponds to Ford's results. Another portion of the extract of brain was tested for reduction after hydrolysis, without result.

Exp. 244 similarly gave a negative result by the reduction method.

The only experiment which gave some indication that the brain may contain a toxic body was No. 236. In this case a young cat, weighing 760 grm., received the emulsified brain of rabbit 234, which had been poisoned with 10 mlgrm. of tutin. After about an hour it showed some twitching of the ears, licking of its lips, swallowing movements, deliberate

winking, and exaggerated respiratory movements; within two hours all these symptoms had disappeared, and at no time were they very pronounced. The animal was fasting, and it may be that the tutin compound, with the tissues, was dissociated in the stomach. This is the only experiment that lends some support to Ford's results.

Liver.—One experiment (No. 240) was done on tutin in the liver, with negative results.

Experiments on the Relative Toxicity of Two Varieties of Tutu.

There is a general consensus of opinion among sheep-farmers that the "fern" tutu (*Coriaria angustissima*) is more deadly than the ordinary "tree" tutu (*Coriaria ruscifolia*). Easterfield and Aston found that all varieties of the plant contain tutin, and estimated the percentage in young shoots of *C. ruscifolia* at 0·03, but no systematic quantitative estimation of the amount of tutin in the different varieties has yet been made.

The experiments which are described here were undertaken with the view of comparing the toxicity of the varieties mentioned above, but I wish to emphasize that this does not settle the practical question as to which is the most deadly to stock, for the palatability and the ease with which the plant may yield its poison are probably more important than slight differences in the percentage of tutin present.

Exp. 201: A quantity (464 grm.) of *C. ruscifolia* leaves, stalks, and fruit was gathered in the end of February. It was minced, covered with water, allowed to steep for fourteen hours, and then pressed through flannel and made up to 1,000 c.c. Of this fluid 50 c.c. per kilo administered by stomach-tube to a rabbit (201) caused death with typical tutin symptoms in three hours and three-quarters. From our former experiments, Fitchett and I found that death resulted in rabbits from a dose of 6 to 8 mlgrm. tutin orally administered; but there is, of course, the great probability that in order to kill the animal more than that amount would be required when the tutin is given mixed with the other extractives of the plant. The experiment shows, however, that at least 0·03 per cent. tutin was present (0·007 grm. in 50 c.c. = 0·14 grm. in 464 grm. of tutu = 0·03 per cent.).

In March of the same year samples of two varieties of tutu were obtained from the slopes of Swampy Hill, near Dunedin. The one variety was certainly *C. ruscifolia*, and from the descriptions given I believe the other to have been *C. angustissima*. Each sample was extracted once with water as described above, and a few days later a second extract was made in the same way, and the toxicity of the extracts determined on rabbits by oral administration.

The results were as follows:—

Coriaria ruscifolia (800 grm.).

First extract measured 1,800 c.c. (No. 212) 16 c.c. per kilo: no effect. (No. 213) 40 c.c. per kilo: distinct symptoms; recovered. (No. 214) 45 c.c. per kilo: death in one hour and a half. Assuming that 45 c.c. of the extract contains 0·008 grm., this gives 0·32 grm. tutin in the first extract.

Second extract measured 1,150 c.c. (No. 210) 40 c.c. per kilo: gave slight symptoms. (No. 215) 50 c.c. per kilo: caused death in three to four hours. Assuming that 50 c.c. of this extract contains 0·008 grm., the second extract contained 0·184 grm., or a total of 0·504 grm. tutu in 800 grm. tutu = 0·063 per cent.

A third extract of the same material was made. It measured 1,000 c.c., and of this 60 c.c. per kilo gave no symptoms.

Coriaria angustissima (400 grm.).

First extract measured 862 c.c. (No. 216) 38 c.c. per kilo: very severe symptoms; recovered. Assuming from previous experiments that the dose here was 7·5 mlgrm., the extract may be said to have contained 0·17 grm. tutin.

Second extract measured 862 grm (No. 211) 40 c.c. per kilo: slight symptoms; recovered. (No. 218) 50 c.c. per kilo: more marked symptoms.

The symptoms observed here corresponded to those produced by a dose of about 5 mlgrm. pure tutin, and on that basis the extract would contain 0·107 grm. tutin. The total in 400 grm. leaf would therefore be 0·277 grm., or a percentage of 0·069; but owing to pressure of other work the lethal doses of the extracts of this variety were not so exactly determined as for *C. ruscifolia.*

These experiments, so far as they go, indicate that there is little difference between the actual amounts of tutin present in the two varieties.

PROTOCOLS.

[Only those experiments are described here that are not fully given in the text. For future reference the experiments are numbered in continuity with those of Dr. Fitchett's paper.]

199. Rabbit, used for blood-pressure experiment, received 10 c.c. of 0·5 per cent. tutin injected intravenously in two doses. Animal killed three-quarters of an hour after the first and half an hour after the last dose. Vessels washed out with saline. Blood and washings were precipitated with alcohol, but not examined till some four months later, then extracted repeatedly with alcohol. The alcohol was driven off, and a watery solution of the residue made up to 10 c.c.; 2 c.c. of this was injected into a rabbit without obvious effect, but 1½ c.c. killed a 21 grm. frog in twenty-seven hours, with symptoms of nervous disturbance, such as twitching of hind limbs—muscular weakness with irritable reflexes.

225. 30 c.c. of fresh defibrinated rabbit-blood incubated five hours at 40° C. with 2·62 c.c. of 0·5 per cent. tutin was administered by stomach-tube to a rabbit weighing 1·31 kilo (=dose of 10 mlgrm. per kilo). Severe tutin symptoms resulted, with recovery of animal. The dose here was slightly above the usual fatal one.

226. Mashed brain of recently killed rabbit + 5 c.c. of 0·5 per cent. tutin, incubated overnight at 40° C. Extracted with alcohol, and watery extract of residue made. A dose of this extract proved fatal to a frog, while a similar dose of an extract of rabbit-brain without the addition of tutin did not kill a control frog.

229. Cat, pregnant, weight 3·7 kilo, gave 3·7 c.c. of 0·5 per cent. tutin solution (five years old). Dose, 5 mlgrm. per kilo; actual amount, 0·0185 grm. Twitchings began in four minutes. To allow of complete absorption of the dose, she was kept under A.C.E. anaesthesia for about twenty minutes. The convulsions were largely modified in severity by the anaesthesia. On removal of the anaesthesia they became very severe. Animal was killed by bleeding forty minutes after dose given. Uterus contained three foetuses. Brain and upper part of spinal cord weighed 27·5 grm.; brains of foetuses, 7·5 grm.; blood obtained, 56 grm.

Cat's brain was mashed in mortar, extracted repeatedly with boiling water, filtered, evaporated to 27·5 grm. (=original weight). Tested with Fehling before and after hydrolysis with HCl, but got no reduction. Some

of the fluid was concentrated and injected into a frog; it caused death. A similar quantity treated with alkali, neutralized, and injected into another frog also caused death. Neither frog showed tutin symptoms.

Foetal brains treated together in similar way and filtrate concentrated to small bulk: whole filtrate hydrolyzed with HCl gave slight but distinct reduction. No test made before hydrolysis because of small bulk of fluid, and result would need to be controlled by using normal foetal brains.

Blood.—An extract of the blood of this animal gave reduction with Fehling without hydrolyzing. To distinguish whether tutin was present, the blood was evaporated to dryness on filter paper, and extracted with hot ether; the ethereal extract was extracted with water after driving off the ether. This extract gave no reduction before or after treatment with HCl.

237. Young cat, weight about 850 grm., received orally the alcoholic extract of dried blood of rabbit 234 (dosed with 10 mlgrm. tutin). As described in the text above, the extract represented about 33 c.c. of blood. At 12 noon, dose administered; 12.3 p.m., very distinct twitching of the ears; 12.14 p.m., twitching continues, licking its lips and swallowing frequently; 12.22 p.m., drowsy appearance, deliberate winking, and exaggerated breathing; 1.3 p.m., no symptoms apparent except drowsiness. When seen again at 3.18 p.m. it appeared normal.

(If the tutin in rabbit 234 had been uniformly distributed, the 33 c.c. of blood would have contained 0·164 mlgrm: this to a cat weighing 800 grm. = 0·2 mlgrm. per kilo. But a control experiment on a sister cat showed that 0·21 mlgrm. per kilo given orally in milk produced no effect. We may conclude, therefore, that the blood of No. 234 contained more than its due proportion of the poison.)

238. Young cat, weight 760 grm., received an extract of the muscles of rabbit 234 (dosed with 10 mlgrm. tutin). The dried muscle weighed 35 grm., representing, therefore, over 100 grm. body-flesh. The greater part of this extract was successfully administered to the cat, and beyond urination and some quickening of respiration no obvious effect followed.

240. Rabbit, weight 1,350 grm., received 10 mlgrm. tutin intravenously. Twenty-two minutes afterwards, when practically dead, the blood was collected, and the liver, muscles, brain, and cord excised and treated in the usual way for extraction of tutin. The extract of muscle, representing 100 grm. to 200 grm. of flesh produced no symptoms on oral administration to a cat weighing 812 grm. The extract of liver, representing 30 grm. fresh substance, tested on another young cat produced no symptoms beyond urination and defaecation, which might be attributed to the bile salts and other normal extractives.

244. Young cat, weight 812 grm., received hypodermically 15 mlgrm. tutin. Symptoms became severe in ten minutes, and lasted an hour, at end of which time the animal was killed by bleeding. The temperature fell steadily all the time (37° C. to 32° C. at death). A test-tubeful of blood of this animal yielded very little serum, which did not reduce Fehling either before or after hydrolyzing, while the blood of a normal cat killed by chloroforming at the same time gave the usual proportion of serum, and this serum reduced Fehling easily before, and still more so after, hydrolyzing with HCl.

My sincere thanks are due to Mr. Aston, of the Agricultural Department, Wellington, for supplying me with pure crystallized tutin.

ART. XXXIII.—*The Geological History of the Westport–Charleston High-level Terraces.*

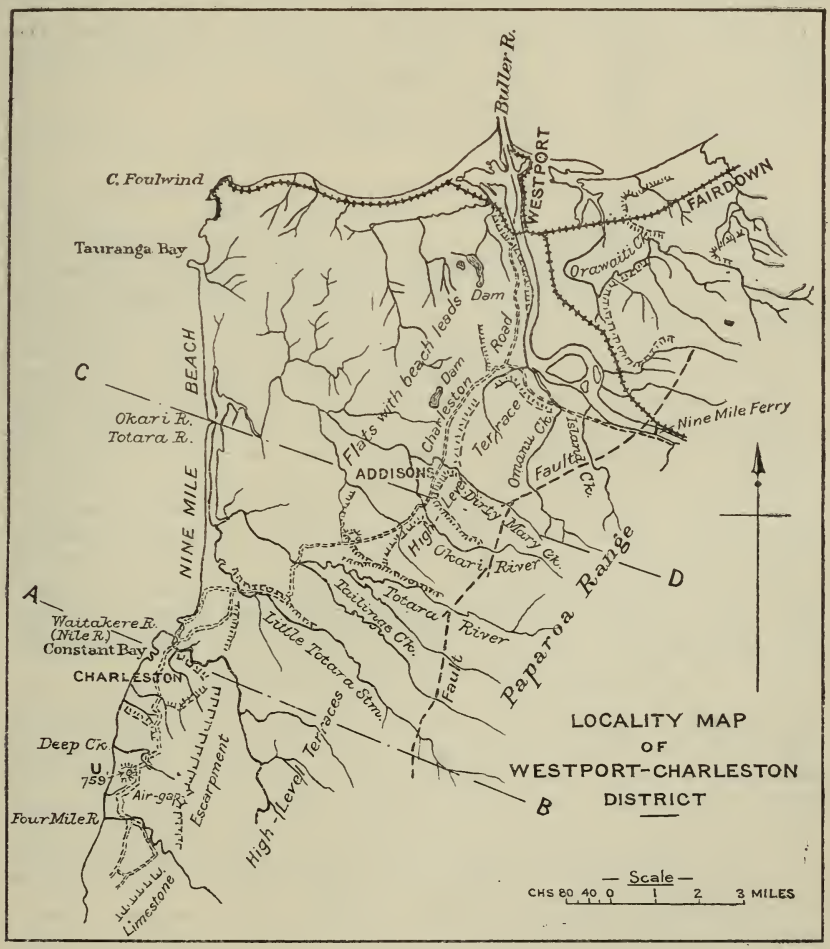
By J. A. BARTRUM, New Zealand Geological Survey.

(By permission of the Director of the Geological Survey.)

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

INTRODUCTION.

THE first physiographical feature in the neighbourhood of Westport to arrest the attention of an observer is the abruptness with which the mountains a few miles from the town rise from a comparatively low coastal



strip to heights ranging between 4,000 ft. and 5,000 ft. The next noteworthy feature is the regularity and persistence of a prominent high-level terrace nestling not far from the steep lower slopes of the mountains. The general surface of this terrace is about 500 ft. above sea-level, or 250 ft.

above the general level of the great coastward expanse of more or less flat open or "pakihi" country which rises gradually from near sea-level to an altitude of approximately 250 ft. at the base of the higher terraces near Addison's.

McKay* alone of many writers upon the geology of the Westport district has given the elucidation of the geological history of these terraces and flats any serious attention, and it is with the hope of enlarging upon the foundation already laid by McKay that these notes have been written.

Sketch of General Geology.

The various geological formations encountered in the Westport–Charleston district, which forms the area discussed in this paper, in ascending order, are :—

(*a.*) Folded argillites and greywackes of doubtful age, assigned by McKay† on evidence from the vicinity of Reefton to his Carboniferous "Maitai" formation, intruded by later granitic rocks and by quartz-porphyries, the whole unconformably overlain by

(*b.*) Bituminous coal-measures, commonly considered to be of Eocene age.

(*c.*) Above the coal-measures are Miocene beds. As developed at Cape Foulwind and Charleston, where, as the writer believes, on account of overlap and not unconformity (a question dealt with later), they rest directly upon the old erosion surface of granite or gneiss, these consist of sandstones with shaly bands and with lignite seams, which attain a thickness of over 25 ft. at Charleston. They are followed by Cobden limestone and then by a great thickness of fine-grained blue marine sandstones.

(*d.*) Unconformably overlying the uppermost Miocene blue sandstones, or "Blue Bottom" as the beds are commonly called on the West Coast, are alluvial deposits of gravel and sand, chiefly the former, constituting high-level terraces and beaches extending from sea-level to a height of over 500 ft. Such gravels have no internal evidence of age, beyond the fact that they are undecomposed, though since their formation they have always been above water-level. As, however, there is apparent conformity in the Greymouth‡ and Reefton§ districts between rotten gravels commonly regarded as Pliocene ("Moutere" or "Old Man" gravels) and the underlying "Blue Bottom," it can safely be asserted that these are younger —viz., post-Pliocene to Recent. They consist in part of reassorted fluvio-glacial gravels, and hence are at least in part post-Glacial.

The question of conformity or unconformity between the Eocene coal-measures and the Miocene beds is much in debate; in the Westport, as in the Greymouth¶ district, there is strong evidence of widespread unconformity in water-worn fragments of coal present in mudstones and sandstones immediately above the bituminous-coal measures. It is pro-

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* "Geology of the South-west Part of Nelson and the Northern Part of the Westland District," Parl. paper C.–13, 1895; and see also McKay and Gordon, "Mining Reserves, Westland and Nelson," Parl. paper C.–9, 1896.

† See particularly "On the Geology of the Reefton District, Inangahua County," Rep. Geol. Expl., 1882, pp. 91–153.

‡ "The Geology of the Greymouth Subdivision, North Westland" (Morgan), N.Z. Geol. Surv. Bull. No. 13, 1911, p. 42.

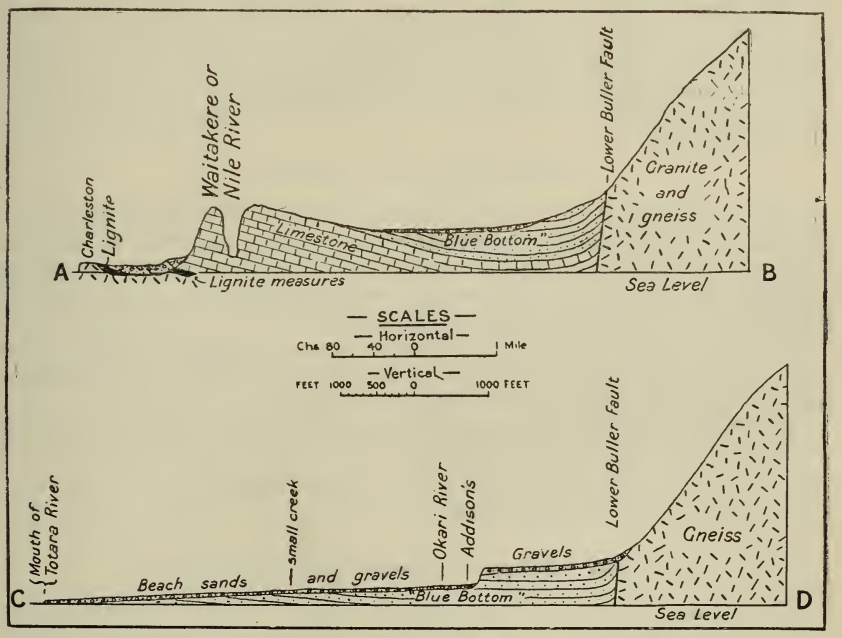
§ Seventh Annual Report, N.Z. Geol. Surv. Department, Parl. paper C.–2, 1913, p. 119 (Henderson).

¶ See "The Geology of the Greymouth Subdivision, North Westland" (Morgan), N.Z. Geol. Surv. Bull. No. 13, 1911, pp. 42, 65.

bable, however, that, in much the same manner as has been suggested by Mr. C. A. Cotton* in explanation of similar conditions in the Tertiary beds of South Marlborough previously described as unconformity, warping allowed erosion of an upraised portion of the coal-measure beds, whilst deposition continued uninterruptedly in a depressed area. It is a significant fact that wherever both are developed the Miocene series has been found invariably to rest in perfect conformity upon the Eocene.

DISTRIBUTION OF GEOLOGICAL FORMATIONS.

The Westport–Charleston district is governed topographically by two main earth-blocks, an upraised one forming the Paparoa Range and its northern continuation, and a relatively depressed coastal block forming the wide lowlands extending from the base of the upland block to the coast.



SECTIONS ALONG LINES AB AND CD OF LOCALITY MAP.

The earth-fracture between these blocks determines the western flank of the Paparoa Range and of the elevated country to the north of the Buller River, and has been designated by McKay† the "Lower Buller" fault. East of it, south of the Buller, granitic and gneissic rocks, and to the north older sedimentary rocks and various acid intrusives, capped by relatively thin Eocene coal-measures, form the mass of the elevated tract.

To the west of the great fault, which has been indicated upon the locality map, soft "Blue Bottom" sandstones extend below Quaternary gravels over almost the whole of the lowland block, and outcrop wherever

* Paper read before Wellington Philosophical Society, 22nd October, 1913 (see p. 286 of this volume).

† "On the Geology of Marlborough and South-east Nelson," Rep. Geol. Expl., 1890–91 (1892), p. 22.

the gravel cap is removed. At Cape Foulwind, and for many miles southwards from the mouth of the Waitakere River along the coast, uptilted inliers of granitic or gneissic rock appear, but cover no great area. Close above the old rock in these localities are the lignite-bearing beds prominent near Charleston, and then again, above these latter, is a definite stratum of Cobden limestone (see section AB). This is seen only as a narrow band at Cape Foulwind, east of which it does not outcrop within the district here described. After a gap of many miles in its southerly trend it reappears at the Totara River, not far above the mouth of this stream, and thence thickens rapidly until near Charleston it attains a thickness of approximately 600 ft. or 700 ft., and, forming a prominent cuesta, with a steep and lofty escarpment facing the sea, continues southward outside the limits of the district studied.

The Eocene coal-measures are absent south of the Buller River from the uplands of the area described, and reach the surface only in the upturned edges of the relatively downthrown coastal block at the base of the Paparoa Mountains in outcrops up several branches of the Fox River, ten miles south of Charleston, and at Omanu or Back Creek, about three miles east of Addison's.

Later Geological History.

Since the date of the "Lower Buller" fault, which has involved the Miocene beds, is evidently post-Miocene, the terraces and flats of the lowlands of the Westport–Charleston district are thus indicative solely of post-Miocene events. For convenience of description the physiographical features of these lowlands may be classed thus :—

(1.) An extended series of high-level terraces, ranging in height from about 450 ft. at the seaward edges to 600 ft. against the mountain-slopes. Such have been designated the "500-foot" terraces.

(2.) The lower-level terraces and flats, similar to Addison's Flat, northwestward of the "500-foot" terraces.

(3.) High-level terraces south of the Little Totara River and east of the limestone cuesta near Charleston.

(1.) *The "500-foot" Terraces* (see Section CD).

The terraces that have been designated the "500-foot" terraces have a remarkable development for thirteen or fourteen miles south-westwards from Fairdown to the Little Totara River. They are almost perfect in uniformity of level, regularity of surface, and marginal outline, and consist of a substratum of "Blue Bottom" capped by gravels from 30 ft. to 60 ft. or more in depth. McKay* states that east of Addison's "black-sand" beach leads are contained by these gravels. These appear to be not far above the floor of Miocene sandstone. Furthermore, beach leads are found in terraces over 500 ft. above sea-level near Charleston, and again at Trig. Station U† (759 ft.), three miles south of Charleston, a typical wave-cut platform is preserved in resistant gneiss. These facts all show that north of the Little Totara River wave-action sculptured the surface of "Blue Bottom" on which the gravels of the "500-foot" terraces rest. South

* "Geology of the South-west Part of Nelson and the Northern Part of the Westland District," Parliamentary paper C.–13, 1895, p. 8.

† Trig. Station U has an additional interest in that it represents a fossil monadnock of the pre-Eocene cycle of erosion.

of the Little Totara the uplifted stratum of moderately resistant limestone seen in the cuesta early resisted the advance of the sea and protected the weaker " Blue Bottom " sandstones overlying it to the east.

The origin and mode of deposition of these gravels are of interest. The basal members, which are said to contain " black-sand " gold-leads, are beach deposits, and it is probable that a great portion of the gravels above these were brought down by the Buller River and other streams, and distributed by wave-action along the shore-line. If it is assumed, as may reasonably be done, that a moderately constant and abundant supply of waste was maintained from the relatively uplifted inland district, it may be concluded that the marine shelf was cut during a period of slight depression, and that during ensuing standstill the progradation of the coast was effected. Sufficient standstill occurred at this juncture to permit of the widening of the bed of the Totara River at its debouchure from the granite and gneiss mountains to a width of about 200 yards where now the present stream flows in a narrow gorge 100 ft. below the lip of this rock platform. The uppermost members of the gravel series were laid down as fan deposits by the Buller River and mountain torrents from the upfaulted Paparoa Mountains during the early stages of a succeeding movement of elevation.

(2.) *Lower Terraces and Flats.*

The terraces and flats forming the extensive lower belt extending seaward from the foot of the higher terraces, and attaining a width of over seven miles between Cape Foulwind and Addison's, are essentially related in origin to the high-level terraces. After the formation of the piedmont plain noted above, elevation of at least 250 ft. ensued, and was followed by a period of standstill, and perhaps of slight depression, causing the re-advance of the sea until the former piedmont plains were cut back and formed an elevated coastal fringe, notched by the Buller River and by the torrential streams from the Paparoa Range, and with high cliffs marking the line of sea-front. South of the Little Totara River the tilted limestone stratum again proved a barrier to wave-advance. At the base of the sea-cliffs highly auriferous beach-drift was deposited, constituting one of the richest gold-leads of the district, and, prior to the re-elevation which now followed, gravels 30 ft. and more in depth were laid as a covering upon the beach-sands by the larger streams, such as the Okari and Totara Rivers, which had time at this stage to widen their flood-plains enormously by the undercutting of the " 500-foot " terraces.

An interesting remnant of the former coastward extension of the high-level terraces which has escaped complete destruction by the advancing sea, and later by the lateral erosion of the Totara River, can be seen beside the Charleston Road, about a mile and a half north-east of the Totara River bridge.

Several pauses during this latest movement of re-elevation are evidenced by the numerous terraces so well seen on the west bank of the Buller. Lines of auriferous beach sands and gravels were also left to mark periods of more especial concentration of the gold present in the drift, which was deposited in moderate abundance by the retreating sea, and have proved of considerable economic value in many localities. The depth of such old beach material is seldom more than about 12 ft. to 20 ft.; with it are often associated erratic boulders and blocks, sometimes 8 ft. and more in diameter, which must owe their present position largely to glacial transport.

(3.) *High-level Terraces South of the Little Totara River and East of the Limestone Cuesta near Charleston.*

The "500-foot" terraces described lose their distinctive character south of the Little Totara River; some hummocky country of slightly greater elevation, consisting of dissected "Blue Bottom," intervenes for a short space, and then commences a great belt of level gravel-capped "Blue Bottom" terraces, with an altitude of about 600 ft., occupying a depression between the edge of the gneiss mountains and the coastward limestone ridge, which slopes gently inland along the dip of the beds from the crest of its high escarpment. Against the mountains the "Blue Bottom" beds are steeply tilted by the main fault, and there attain an elevation of over 1,000 ft. Even at this altitude traces of terraces, cut by the streams now flowing 400 ft. or 500 ft. below in deeply cut gorges, are plainly delineated.

The depression to which attention has just been drawn continues in a south-south-west direction many miles to the south of the area shown in the locality map illustrating this paper; its drainage is effected by moderately large streams flowing in a general north-west direction from the Paparoa Range and cutting in deep gorges through the coastal limestone ridge to which they are antecedent.

Two such streams near Charleston are the Waitakere and Four-mile Rivers. There is evidence in a wind-gap south-east of Trig. Station U in the limestone cuesta, of another large stream having formerly flowed north-west across this ridge. Probably the gneiss floor of the Miocene beds has intervened at a higher altitude here than in the case of the existing streams, and, owing to failure to corrade the resistant rock sufficiently rapidly, the drainage of this valley inland of the cuesta was captured by the Waitakere and Four-mile Rivers, and thus reversed.

McKay* draws attention to the fact that despite vigorous prospecting no auriferous black-sand or other leads have been discovered in the gravels of these widespread terraces. He noted the inland depression, and, speculating upon the absence there of beach leads, considered that most probably it was due to these having been removed by denudation, although he states at the same time that this absence may possibly have been caused by "inequality of level affecting the areas east and west of the limestone." The writer believes that the limestone has been an effective barrier to wave-encroachment during and since the period of sculpture of the highest wave-formed terraces or platforms of the district, and that the depression, with its gravel cap, is the work of the streams now transecting and draining it at a period corresponding to that when the "500-foot" terraces were formed, since there was then considerable standstill. Prominent elevated more-recent flood-plains of the Four-mile River, cut in the weak Miocene sandstones beyond the eastward limit of outcrop of limestone, are largely dependent in origin on the control of stream-grade by the local base-level of erosion caused by a resistant gneissic barrier at the Brighton Road bridge across the Four-mile River. At this place, which, though only one mile from the coast, is at an altitude of approximately 350 ft., the stream is slowly lowering its bed below the lip of the low gorge already cut.

Further Details of the Charleston District.

At Charleston, where everywhere is semi-obliterated record of the remarkable industry of the early gold-diggers, auriferous beach leads were

* Geology of the South-west Part of Nelson and the Northern Part of the Westland District," Parliamentary paper C.–13, 1895, p. 23.

worked on at least six different terraces. All of these show evidence of former wave-action not only in the character of the covering alluvium, but also in the characteristic planing of the hard gneiss and overlying soft Miocene lignite-bearing beds into remarkably uniform terraces, with here and there a residual undestroyed hummock of gneiss. In nearly all cases gneissic rock forms a protective barrier on the seaward side of the terraces, and where this has been absent—for example, near the mouth of the Waitakere River—the removal of the weak beds underlying the Miocene limestone has been more complete, and beach deposits attain a thickness of at least 150 ft. in the locality mentioned.

As has already been suggested, the peneplained surface of gneiss on which the Miocene beds of the Charleston were deposited did not have its inequalities entirely reduced. It appears, however, from various details of evidence that a great part of the present irregularity of the exposed fossil peneplain, forming a large part of the surface of the coastal strip south of Charleston, is due to the displacement of small earth-blocks along unimportant fractures, trending probably in a north-west and south-east direction. These accompanied a tectonic movement in which the beds were broadly arched into a south-eastward plunging anticline. This fact is demonstrated by the uprise of the base of the limestone band, in a direct line between its outcrops in the Waitakere and Fox Rivers, from approximately sea-level at these localities to an altitude of about 500 ft. or 600 ft. near the Four-mile River. Similar tectonic movements are abundantly evidenced in all parts of the Buller Coalfield; it is probable that the earth-stresses giving rise to them have continued in operation to the present day, and are those responsible for the severe earthquakes* experienced in the district in February, 1913, which were due to the subsidence of an earth-block several miles south-west of Cape Foulwind.

RÉSUMÉ OF POST-MIOCENE GEOLOGICAL HISTORY.

From the fact that small quartz-pebble bands are present in the upper "Blue Bottom" near the Paparoa Range, in the valley of the Waitakere River, it appears that the present western slopes of the range must have been not far from the old land of Upper Miocene times. Of the shore-line of this old land nothing definite is known. Orogenic movements, which had already caused warping and unconformity between the bituminous coal-measures and the succeeding Miocene beds over a considerable portion at least of the West Coast area, became again active at a period post-dating the close of Miocene sedimentation, and the uplift of the Paparoa block relatively to the coastal earth-block resulted. The question whether the whole area of Miocene deposition was uplifted *in toto* before faulting occurred, or whether uplift was relative in the various earth-blocks, need not be discussed here.

In post-Miocene times the upper strata of the weak "Blue Bottom" sandstones north of the Little Totara River were planed off by wave-encroachment back to the barrier afforded by the resistant granitoid rocks of the Paparoa Mountains, whilst south of the Little Totara the limestone proved an effective barrier to the advance of the sea. Upon this wave-cut platform the gravels of the "500-foot" terraces were deposited. Prior to the formation of this plain of marine erosion, now buried below the gravels, uplift varied by standstill, and perhaps by slight depression, had been in

* Hogben, G.: Paper read before the Wellington Philosophical Society, 24th September, 1913 (see p. 301 of this volume).

progress, and the surface of the monadnock at Trig. Station U was levelled by wave-action at this time.

The uplift continued after the deposition of the gravels of the "500-foot" terraces, and the land rose at least 250 ft.; again a period of considerable standstill and probable slight depression intervened: the sea advanced upon the recently formed strand-plain, and wore it back until a bold line of high sea-cliffs marked the edge of the present high-level terraces. The movement of uplift was renewed, and continued intermittently until comparatively recent times, the various periods of standstill being well illustrated by numerous terraces, such as those well developed where the Buller and Totara Rivers cross the coastal lowlands. It is tolerably certain that depression varied the main movement of uplift, such depression being indicated in particular by the relations of the Pleistocene beach-sands to the Tertiary and older underlying rocks near the mouth of the Waitakere River (see section AB). The covering of drift over the lowlands consists largely of beach deposits left as the sea retreated; but, in addition, a quantity of material has been brought down and deposited by the Buller River on its lateral terraces, deposition having taken place owing to the seaward extension of the delta of that river during the early stages of uplift.

The most recent events in the geological cycle have been the formation of the present Buller delta and a general prograding of the coast-line, except where rocky headlands disturb the uniformity of the sea-margin and are being rapidly undercut into steep and lofty cliffs. These events are still in progress.

ACKNOWLEDGEMENTS.

In conclusion, the writer wishes to thank Mr. P. G. Morgan, Director of the Geological Survey, for permission to present this paper, and Mr. G. E. Harris, of that Department, for assistance in the preparation of locality map and sections, and to express his indebtedness to Mr. C. A. Cotton, of Victoria College, for much helpful criticism and advice.

ART. XXXIV.—*Some Intrusive Igneous Rocks from the Westport District.*

By J. A. BARTRUM, New Zealand Geological Survey.

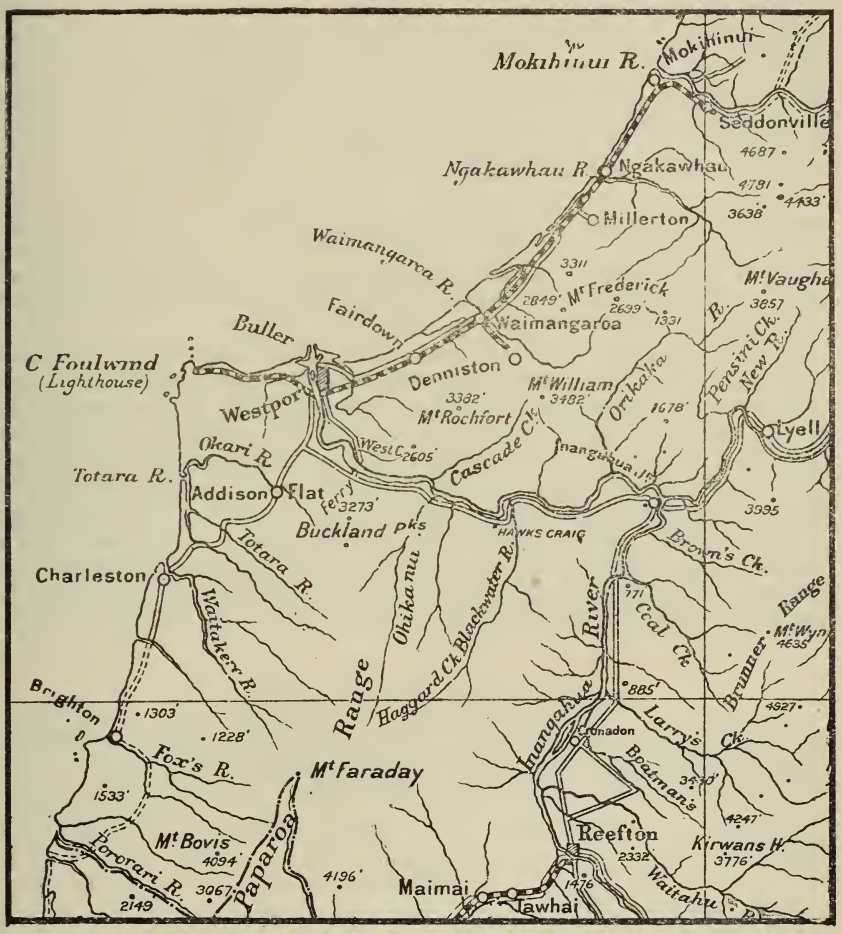
(By permission of the Director of the Geological Survey.)

[*Read before the Wellington Philosophical Society, 27th August, 1913.*]

INTRODUCTION.

THE aim of the present paper is to give a petrographical account of several interesting rock-types encountered during the course of the recent work of the Geological Survey in the Westport district. A statement of consanguinity and absolute classification can only be made when the requisite chemical analyses are available, but it is believed that the petrographical descriptions indicate these sufficiently well in most cases. Since one rock, however—provisionally classed as a syenite-porphyry—has a rare occurrence in New Zealand, it would be more satisfactory were the classification justified also by chemical analysis. Another type—a monchiquite—though known

previously from the river-gravels and old moraines of Central Otago, has not as yet been recorded from the West Coast district. This monchiquite was found by Mr. P. G. Morgan in the boulders of Rider Creek, a small headwaters tributary of the Blackwater River, and, although the outcrop



LOCALITY MAP, WESTPORT DISTRICT.
(Scale, 1 in. to 10 miles.)

of the dyke shedding these boulders was not located, a similar type and several camptonites were traced by Mr. Morgan to their parent dykes in the vicinity.

Camptonites have been recorded by Bell and Fraser* from the Hokitika district, and Dr. J. Henderson† has determined these and other types of lamprophyres in gravels near Reefton; it is only during the past year, however, that any of these rocks have been discovered *in situ* around either Reefton or Westport.

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* Bull. No. 1 (n.s.), N.Z. Geol. Surv., pp. 82–83, 1906.

† Personal communication (see also Trans. N.Z. Inst., vol. 45, 1913, p. 315).

General Geology.

It is beyond the scope of this paper to deal with the general geology of the district, and a brief sketch will suffice to establish the geological relations of the rocks described.

The oldest rocks exposed are argillites and greywackes, classed by McKay* in the Maitai series of Carboniferous age, which are equivalent to the Greenland formation described by Morgan† in the Blackball district and in Westland. These sediments have been intruded by the immense mass of granite that has such an important development along the western flanks of the Southern Alps in Nelson and Westland.

The coal-measures and succeeding Tertiary beds were deposited upon a more or less irregular erosion surface of the argillites and greywackes and upon the granite which had been laid bare by denudation. Since the deposition of these Tertiary beds, major uplift, various oscillatory movements of uplift and depression, prolonged denudation, and profound and complex fault-fracturing have all contributed towards the present configuration of the district.

At some period following the deposition of the basal beds of the coal-measures lamprophyres were injected in dykes that transect both the granite and the basal breccias of the bituminous-coal series. The upward limit of these dykes has not yet been determined with certainty, but they have not as yet been found to pass above the horizon of the basal coal breccias.

It has not been ascertained to what extent the intrusion of the granite has metamorphosed the older sediments; the prevailing feature of the contact alteration immediately adjacent to the granite is the development of hornfels, but widespread gneisses outcrop in some parts of the district, and these probably owe their structure to the pressure and other circumstances attendant on the granitic intrusion.

Petrography.

The rocks to which attention has been directed in this paper are—(1) biotite-hornblende granite; (2) granitic gneiss with abundant epidote; (3) syenite-porphyry; (4) diorite; (5) lamprophyres; (6) dolerite.

Besides the above, many other more widely distributed types occur, but, as these are in most cases not of special interest, they have not been described.

Literature.

So far as the writer is aware, the only petrographical papers dealing with the igneous rocks of the Westport district are the following:—

1889: Hutton, F. W.—"Description of some Eruptive Rocks from the Neighbourhood of Westport, New Zealand," Trans. Geol. Soc. of Australia, vol. 1, 1889 (?), pp. 106–10.

1889: Hutton, F. W.—"The Eruptive Rocks of New Zealand," Trans. Roy. Soc. N.S.W., vol. 23, 1889, pp. 102–56.

1889: Hutton, F. W.—"Note on the Geology of the Country about Lyell," Trans. N.Z. Inst., vol. 22, 1889, pp. 387–90.

1906: Sollas, W. J., and McKay, A.—"The Rocks of Cape Colville Peninsula," vol. 2, p. 159. (Sollas describes a section cut from the gneissoid granite of Cape Foulwind.)

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* "Papers and Reports relating to Minerals and Mining," Parliamentary paper C.–13, p. 27, 1895.

† Bull. No. 13 (n.s.), N.Z. Geol. Surv., and Bull. No. 6 (n.s.), N.Z. Geol. Surv.

Many descriptions of rocks, based solely, however, on macroscopical examination, appear in various reports dealing with the geology of the district. These cannot be considered to be of sufficient petrographical interest to warrant the inclusion of the reports in which they are embraced in the above list.

The writer has been unable to gain access to a copy of Hutton's paper, "Description of some Eruptive Rocks from the Neighbourhood of Westport, New Zealand," but it is probable that the later paper, "The Eruptive Rocks of New Zealand," embraces all the rock-types that Hutton discovered near Westport. Amongst these, syenite, diorite, and dolerite—types analogous to those described by the present writer—have been recorded.

DESCRIPTION OF ROCK-TYPES.

(1.) *Biotite-hornblende Granite.*

A biotite-hornblende granite outcrops on the beach north of the Mokihinui River, at about 300 yards south of the Grenadier Rocks. In hand-specimen it is a typical even-grained granite, showing dull, chloritized ferro-magnesian minerals. Under the microscope the minerals observed are quartz, orthoclase, oligoclase, brownish-green biotite, deep-green to pale-yellow hornblende, subsidiary apatite, zircon, and muscovite, and secondary chlorite, epidote, pyrite, calcite, sericite, and quartz.

Orthoclase and quartz are very abundant, whilst plagioclase also is common; consequently the rock has a leucocratic appearance. The biotite is almost invariably chloritized, or represented by pseudomorphs of chlorite, epidote, and sphene, and is greatly in excess of the amphibole.

The structure is not typically granitic, since the feldspar and amphibole are idiomorphic, and the former mineral has preceded the latter in the order of cessation of crystallization. Pressure has caused strain-shadows to be exhibited in the quartz.

(2.) *Granitic Gneiss with Abundant Epidote.*

A granitic gneiss containing a great abundance of epidote, and presenting some unusual features, was found near the debouchure of West's Creek, a small tributary of the Buller River between Westport and the Nine-mile Ferry.

In its present state it is a gneissic rock with irregular mosaic bands of coarse dentated crystals of quartz showing noteworthy undulose extinction. Besides this indication of partial granulation and recrystallization, another frequent and interesting characteristic of the quartz is a prominent fine parallel banding, easily distinguished in ordinary light by reason of slight differences in intensity. It is probable that a replacement of original plagioclase is thus represented, for this striation exactly simulates albite twinning, and in this event a part at least of the quartz must have been introduced during the replacement of the plagioclase. Silicification of plagioclase in schistose and gneissic rocks has been described by Mr. P. G. Morgan from the Mikonui district*; the writer examined several slides of the rocks in question, but found that the silicification there shown was of the ordinary micro-granular nature.

In addition to quartz, the minerals present in the West's Creek gneiss are plagioclase, cryptoperthite and orthoclase, abundant biotite, epidote, and chlorite, accessory zircon and sphene, a few clusters of fine radiating

* Bull. No. 6 (n.s.), N.Z. Geol. Surv., pp. 88 *et seq.*, 1908 (see particularly Nos. 8 and 16).

needles of tourmaline replacing feldspar, a little magnetite, and a moderate amount of sericite derived from feldspar. The plagioclase—an oligoclase-andesine variety—is in excess of the alkali-feldspar. The biotite is partially chloritized, and is probably in part secondary; its lamellae are frequently bent. The epidote occurs abundantly in more or less idiomorphic crystals, which exhibit faint pleochroism and are similar in general characters to hypersthene, but can be distinguished from this mineral by the transverse position of the axial plane compared with the elongation. Apart from the induced gneissic character the structure is typically granitic.

A rounded basic segregation or inclusion, of about 1 ft. in diameter, occurring in this gneiss was examined and proved to be a diorite with abundant amphibole. A moderate amount of epidote is again present, with plentiful biotite and sphene. The constituent minerals are markedly equidimensional. On the assumption that this is a segregation in the rock now represented by the above-described gneiss it would appear that this latter rock was originally related to the diorites, and perhaps could have been classed as a monzonite, following Hatch's usage of that name.*

(3.) *Syenite-porphyry.*

The rock here described as a syenite-porphyry outcrops in a dyke at least 20 ft. wide contained in granite in Slug Creek, a branch of the Pensini Creek, Buller Valley. Macroscopically it is a fine-grained grey granitic rock showing crystals of biotite, feldspar, hornblende, pyrite, and doubtful quartz; under the microscope, however, no quartz phenocrysts were observed.

This syenite-porphyry is essentially a fine granular mass of feldspar with a little biotite and quartz enwrapping conspicuous phenocrysts of the minerals noticeable in the hand-specimen. The plagioclase—an oligoclase-andesine variety—is idiomorphic, whilst the orthoclase is commonly corroded. The former feldspar is subsidiary to the orthoclase, particularly in the groundmass. Perthitic intergrowths are occasional.

Green, highly pleochroic hornblende, in long prismatic crystals, and dirty-green to yellowish-brown biotite are subequal in amount. Yellowish epidote and chlorite are common alteration-products of the amphibole. Calcite and pyrite are other secondary minerals present.

Although the apparent predominance of potash-feldspar warrants the tentative classification of this rock as a syenite-porphyry, such classification cannot be regarded as final until justified by chemical analysis.

It must be noted that Hutton† has described a hornblende-syenite from near the beach 16¾ miles north of Westport. The outcrop has not been located by the present Geological Survey, although a similar type of rock has been found in boulders up Stony Creek, at Waimangaroa.

(4.) *Diorite.*

Diorites and quartz-diorites are moderately common in the Westport district, where their usual mode of occurrence is in dykes that transect the general granite. A general description of them has not been attempted, but an interesting type found in boulders in the Fox River has been selected for description.

Macroscopically this rock is a holocrystalline dark-green diorite showing prominent coarse amphibole crystals. Under the microscope it is seen to

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* "Text-book of Petrology," 6th ed., London, 1910, p. 153.

† "The Eruptive Rocks of New Zealand," 1889, p. 123.

consist of approximately equal proportions of andesite-labradorite on the one hand, and of hornblende and biotite on the other. The texture is very coarse, and the hornblende presents idiomorphic outlines to the feldspar and biotite. This amphibole is a deeply pleochroic bluish-green to pale yellowish-green variety, and commonly shows separation of iron-ore along its cleavage-traces. Twinning is very common. The form of alteration is to a fine fibrous mineral that resembles actiniolite, with the exception that the strong pleochroism of the unaltered amphibole is retained. Minute strings of sphene are associated with and appear to be derived from the primary amphibole. The feldspar, commonly altered to sericitic aggregates, forms coarse irregular crystals, which enwrap the ferro-magnesian and other earlier minerals.

The deep-green pleochroic biotite suggests by its association with the amphibole that it is derived therefrom ; it is commonly chloritized. Frequently in association with the biotite and its alteration-products are nests of secondary tremolite. Further minerals present in the diorite are sphene, plentiful coarse apatite, pyrite, iron-ore, and epidote. The sphene is in most curious coarse strings, helping to fill cracks which are partially occupied by feldspar that has been dissected by the original fractures. The origin of the titanium required for the formation of the sphene is obscure ; much of it, however, may have been derived from the biotite and amphibole. The epidote forms coarse crystals with very bright yellow tints and strong pleochroism. In the central portions of most of these yellow crystals are well-defined and moderately extensive cores of a strongly pleochroic mineral showing colours varying from sepia-brown to faint grey. The optical character is negative, and the axial plane at right angles to the elongation. The birefringence is high. The writer was unable to obtain more conclusive tests, but considers that the mineral must be classed as an epidote allied to orthite. A similar association of epidote and orthite is fairly well known with granites from America and elsewhere ; the primary origin of such epidote has frequently been suggested.

(5.) *Lamprophyres.*

As already indicated, no record exists of lamprophyres having previously been found *in situ* in the Westport district, unless, as is possibly the case, a rock from near Lyell described by Hutton as a dolerite* should correctly be termed a camptonite.

The lamprophyres are chiefly camptonites, but sections made from stream-boulders and from one dyke reveal the presence also of monchiquite.

Camptonites.—The Westport rocks classed as camptonites agree well with the type as defined by Rosenbusch.† Sections from several dykes in the Blackwater River watershed exhibit differences one from another which at first appear important, but, to a large extent, gradations in texture and in weathering account for these. The freshest most typical camptonite section prepared represents a portion of a narrow dyke in the basal breccias of the coal-measures near the mouth of Haggard Creek, a tributary of Blackwater River, Buller Valley. Sections were cut from other portions of the dyke, and show a passage from the typical camptonite to a monchiquite, in which, in place of the feldspar of the camptonite, there is a moderate amount of colourless isotropic base crowded with crystallites and enclosing minute prisms of augite and amphibole.

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* "Note on the Geology of the Country about Lyell," 1889.

† "Microskopische Physiographie," Band 2, 1 Hälfte, pp. 684 *et seq.*

In hand-specimen the camptonites are fine-grained blackish rocks showing few, if any, determinable crystals. Under the microscope the most noteworthy features are the precise idiomorphism of the constituent minerals, the great abundance of augite (which forms nearly 50 per cent. of the rock), and the lack of importance of feldspar. The essential minerals are pseudomorphs of iddingsite after olivine, violet titaniferous pleochroic augite, brown hornblende, magnetite, and plagioclase. The only porphyritic mineral is augite, which, with olivine and occasional iron-ore, forms the phenocrysts of the porphyritic types; even in the groundmass, where its stumpy prisms exclude almost all other minerals, it is sharply idiomorphic. In the porphyritic types the pyroxene is usually in "glomeroporphyritic" phenocrysts, the individual crystals of which show good "hour-glass" structure.

Olivine is represented solely by pseudomorphs of yellowish-green iddingsite; these are characteristically idiomorphic, moderately coarse, and very plentiful. In one instance a little serpentine showing "mesh" structure is associated with the iddingsite of a pseudomorph. In the rock from one dyke olivine is absent, unless it is represented by rounded pseudomorphs of carbonate, which are particularly abundant, and in some cases possess an outline characteristic of olivine. The amphibole is a deep-brown, rather poorly pleochroic variety, probably barkevicite; it forms characteristic slender cigar-shaped prisms, which, with a moderate amount of fine magnetite, crowd the clear feldspathic base between the numerous stumpy augite crystals of the groundmass. The feldspar—andesine-labradorite—is in long irregular laths usually of small size, or in small crystals embracing all the other minerals and crowded with numerous colourless acicular crystallites. Occasionally it forms most curious arborescent growths. Secondary carbonates are usually abundant.

In some sections—namely, those from the dyke in Haggard Creek—the iron-ore is in coarse well-shaped crystals typical of magnetite; zonal intergrowth with ilmenite has taken place, and is represented by a more or less regular internal band of leucoxene parallel to the periphery of the crystal. In the clear portions of the groundmass microscopic pinnate growths of iron-ore are often present.

In a section made from one of the Blackwater River dykes several clear glassy rounded patches of isotropic mineral were observed; these probably represent a feldspathoid mineral, but the rock was too decomposed to permit of determinative tests being applied.

Monchiquites.—Boulders of typical monchiquite were found by Mr. P. G. Morgan in Rider Creek, a branch of Haggard Creek; and, in addition, as already mentioned, sections from the camptonite dyke in Haggard Creek have a glassy base, and can well be classed as monchiquite.

There is a general similarity in mineral constitution between the monchiquite and the porphyritic camptonite already described. Olivine, much of which is fresh and the rest pilitized (talc and tremolite), is in large remarkably idiomorphic phenocrysts, which are often surrounded celyphitically by augite. This latter mineral differs from that in the camptonite in that brown hornblende very frequently forms a parallel terminal outgrowth to its prisms, but otherwise shows the same features. In the groundmass it is in segregations, along with a little iron-ore. These are enwrapped by a clear base containing plentiful laths of feldspar and crowded with crystallites, some of which appear to be green hornblende. Staining tests reveal the presence of a few minute needles of feldspar, and indicate that a moderate amount of gelatinizing isotropic material is also present.

(6.) *Dolerite.*

A dolerite* has been described from near Lyell by Hutton. The writer has found no reference other than this to dolerites in the Westport district. Hutton's type is totally different from that herein noted, and, as has already been mentioned, the Lyell rock is possibly a camptonite.

The dolerite now described is found in boulders deposited, along with much greywacke debris, by small streams crossing the Karamea–Mokihinui Road not far from the ford of the left branch of the Six-mile Creek. In hand-specimen it is a dark-green basic rock with fine laths of feldspar prominently displayed on partly weathered surfaces. Seen under the microscope, the dolerite is even-grained, holocrystalline, and fairly coarse, and shows most interesting and perfect ophitic structure. The main constituent is andesine in typically long laths, between and around which is abundant augite, its boundaries thus sharply defined by the dominating laths. Iron-ore, chiefly ilmenite, is in noteworthy amount; it precedes the augite and follows the feldspar. Some of it is secondary. A few zircon prisms, pyrite, secondary calcite, chlorite, and uralite, with a little biotite, were also observed.

The augite is widely altered, but frequent cores and crystals show that it is a pale-pink titaniferous variety. Uralitization, the first stage of the alteration, is effected in two steps — first to a fibrous brownish-yellow, faintly pleochroic, and strongly birefringent amphibole, and then to a bluish-green pleochroic product. The final stage is the change of the uralite to chlorite, with a few minute flakes of biotite. In a few cases there is direct chloritization of the augite, with accompanying separation of a little iron-ore. A little of the biotite in the rock seems to be a product, along with iron-ore, of magmatic resorption of the augite.

RELATIONS OF THE ROCKS.

The granites have already been briefly dealt with in connection with the general geology of the district; from these the gneissose granites cannot be separated.

The diorites, syenite-porphyry, and probably the dolerite are directly connected with the granite intrusion, and probably not long posterior to it, for they were subjected to the same erosion as the granites before the deposition of the coal-beds.

The lamprophyres must probably be correlated with the similar rocks described by Bell and Fraser† from the Hokitika district, and furnish reliable data for the determination of the age of the series, since in the Blackwater Valley they intrude the basal beds of the bituminous-coal measures.

Descriptions of similar rocks from Mount Tapuaenuka district, Marlborough, and notices of some from the Reefton gravels (per Dr. J. Henderson), have appeared lately in a paper by Dr. J. A. Thomson‡ "On the Igneous Intrusions of Mount Tapuaenuka, Marlborough."

ACKNOWLEDGMENTS.

In conclusion, the writer wishes to acknowledge gratefully the kindly help that he has received from Dr. J. A. Thomson, particularly in the determination of some of the minerals, and also to thank Mr. P. G. Morgan, Director of the Geological Survey, for his courtesy in allowing this paper to be presented.

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* "Note on the Geology of the Country about Lyell," 1889.
† Bull. No. 1 (n.s.), N.Z. Geol. Surv., pp. 82–84, 1906.
‡ Trans. N.Z. Inst., vol. 45, pp. 308–15, 1913.

Art. XXXV.—*Unconformities in the Stratified Rocks of the West Coast of the South Island.*

By P. G. Morgan.

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

Introduction.

The area in which occur the unconformities described in this paper lies to the westward of the Southern Alps, and is in shape a drawn-out triangle having its base to the north and its extremely acute apex to the south. Both by reason of its physical isolation and because of other peculiarities this region forms a geological unit, the history of which may to some extent be considered separately from that of other parts of New Zealand. Since only a comparatively small portion of the area has been surveyed in detail, no complete statement regarding the unconformities that occur in the stratigraphical succession can yet be made, and the present account is confined to those that have been observed during the geological surveys of the Westport district and of that part of North Westland which lies to the west of the Southern Alps.

The order of succession in the sedimentary rocks of these districts is shown by the following table :—

Formation or Series.	Subdivisions.	Approximate Age.
Recent and Pleistocene ..	Marine gravels and sands .. Fluviatile gravels .. .. Glacial gravels	Recent and Pleistocene.
	Unconformity.	
Moutere Gravels ..	..	Pliocene.
Oamaru series	Upper—Blue Bottom, &c. .. Middle { Cobden Limestone .. Port Elizabeth beds .. Lower—Omotumotu beds ..	Miocene.
	Unconformity.	
Bituminous-coal measures (Mawheranui or Waimangaroa series)	Kaiata beds (including Island Sandstone) Brunner beds .. .. Paparoa beds; Hawk's Crag and Brighton breccias	Eocene.
	Great Unconformity.	
Aorere (Greenland) series	..	Ordovician.*

* The Greenland series of New Zealand Geological Survey Bulletins Nos. 6 and 13 is here provisionally correlated with the Aorere series of Bulletins Nos. 3 and 11. Decisive proof of this correlation has not been obtained, but the age of the rocks in question does not materially affect any statement in this paper.

I. THE POST-MIOCENE UNCONFORMITY.

The first unconformity shown in the table of formations is typically a comparatively short break between Pliocene and Pleistocene, and represents a time during which the whole westerly part of the South Island was being rapidly uplifted. Elevation, however, had begun at an earlier epoch—probably before the close of the Miocene—and with the exception of several periods of rest and one well-marked period of depression (near the end of the Pleistocene) has continued till Recent times. Moreover, besides being spasmodic, elevation has been differential in the extreme, block-tilting and faulting being prevalent, so that whilst some areas—for example, the Paparoa and Brunner Ranges—were probably uplifted 5,000 ft. or even more,* others remained almost stationary. These differential movements are roughly reflected by the varying extent of unconformity. Thus in many places Recent gravels rest on Upper Miocene claystones (Blue Bottom), or on still older rocks. At Cape Foulwind horizontal Pleistocene sandstone of marine origin overlies an eroded surface of gently dipping Miocene rocks. In various parts of the Greymouth district unconformity between Moutere or Old Man gravels of Pliocene age and Pleistocene gravels is generally indicated merely by the latter resting on an eroded surface of the former without any noticeable discordance of dip. The plane of contact is usually marked by a layer of large stones, evidently residual from the denuded portion of the Moutere gravels. On the other hand, in a few places a decided discordance of dip may be seen, the most notable instance being at Healy's Gully, north of Blackball, where nearly horizontal Pleistocene gravels rest on steeply dipping Pliocene beds, which are involved in a great fault.†

II. THE POST-EOCENE UNCONFORMITY.

The unconformity between the bituminous-coal measures of Eocene age and the Miocene or Oamaru rocks presents peculiar features, and will therefore be fully discussed. It was announced by the writer in 1909,‡ but since then its existence has been questioned by Marshall,§ partly on the ground that no direct stratigraphical evidence of unconformity has been discovered, and partly for other reasons. The problem is one of great importance, particularly from an economic point of view, for its solution bears directly upon the question of boring for bituminous coal beneath Oamaru rocks near Westport and elsewhere.

The evidence for the existence of a post-Eocene unconformity, including data recently obtained, may be classified as follows :—

A. The Miocene rocks contain water-worn pieces of coal and carbonaceous shale almost certainly derived from the bituminous-coal measures.

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* The total uplift since the Eocene is known to have reached 6,500 ft. in places, but some of this may be ascribed to pre-Miocene elevation : see a later page. If there is no unconformity between Eocene and Miocene, the maximum uplift approaches 10,000 ft.

† P. G. Morgan : "Geology of the Greymouth Subdivision, North Westland," Bull. No. 13 (n.s.), N.Z. Geol. Surv., 1911, p. 74.

‡ Third Annual Report of N.Z. Geol. Surv., Parliamentary paper C.–9, 1909, p. 13. (See also Bull. No. 13 (n.s.), 1911, pp. 65–66, and earlier reports by McKay cited on later pages.)

§ "New Zealand and Adjacent Islands" (reprinted from "Handbuch der regionalen Geologie"), Heidelberg, 1912, p. 68. (See also "The Younger Rock-series of New Zealand," by Marshall, Speight, and Cotton, Trans. N.Z. Inst., vol. 43, 1911, pp. 392–93.)

B. In one place there is discordance in dip between Miocene and Eocene rocks.

C. In various localities Miocene strata are in apparently unconformable contact with Eocene strata.

D. The Miocene rocks exhibit a strong overlap on the pre-Tertiary land-surface.

A. Water-worn Coal, &c., in Miocene Rocks.

The chief evidence for unconformity between the Eocene and the Miocene adduced by the writer in 1909 and 1911 consisted in the presence of water-worn coal in the Omotumotu beds near Greymouth. In the valleys of Kaiata and Omotumotu Creeks, over an area of several square miles, are found mudstones, sandstones, and grits containing innumerable grains and lumps of coal.* These rocks were originally discovered by McKay in 1873, and were described by him in the following terms: "Much of the sandstone [loose blocks in a small creek, probably a branch of the Omotumotu] contained streaks of coaly matter, sometimes as a coal sand, and at other times being rough enough to be called a conglomerate, some pieces thus included being 1½ in. diameter. I went up the creek, and some distance up found beds of this sandstone, and, in one place, the bed whence this coal conglomerate comes. At this point where I observed it it was not more than 6 in. thick, and the coal pebbles small. I, however, saw blocks in the creek-bed that would prove that this coal conglomerate sometimes reached a thickness of a foot. Other beds of the sandstone became coaly, so as to give it a dark colour and a flaggy appearance, but nowhere, except in the one particular bed, did it approach the conditions of a conglomerate. . . . The coal conglomerate and sandstone beds lie all along the western face of the range to the east of Omotumotu Creek."†

In 1900 McKay examined a branch of Kaiata Creek in which coal-seams had been reported to occur, and as a result of his observations stated, "The carbonaceous deposit where examined is about 2 ft. in thickness, and consists of rolled pieces of coal, the largest of which are about 6 in. in diameter, the lesser a fine gravel passing into grit and carbonaceous mud, mixed in varying proportions with arenaceous sands."‡

In both of the reports quoted McKay regarded the presence of water-worn coal in the Omotumotu beds as proof of unconformity with the bituminous-coal measures. In the earlier report McKay correctly placed the Omotumotu beds below the Cobden limestone, but in 1901 he reversed his opinion as to their relative position, thus avoiding the necessity of having to admit an unconformity in the Cretaceo-tertiary formation.§

In the Westport district the lower Miocene beds of two localities contain pebbles of water-worn coal and of carbonaceous shale apparently derived from the bituminous-coal measures. In February, 1911, when traversing Hodge's Creek, a small stream entering the Mokihinui River near Seddonville, the writer and Dr. J. Henderson found a few water-worn coaly fragments in a sandy mudstone which is probably of estuarine origin, and lies near the base of the Miocene strata as developed in the Mokihinui district.

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* N.Z. Geol. Surv. Bull. No. 13 (n.s.), 1911, pp. 65–66.

† "Reports relative to Collections of Fossils made on the West Coast District, South Island." Rep. Geol. Surv. during 1873–74, No. 8, 1877, pp. 78–79.

‡ "Report on Supposed Coal-seams in Kaiata Range, Greymouth." Mines Report, 1901, Parliamentary paper C.–10, p. 7.

§ *Op cit.*, p. 8. (See also N.Z. Geol. Surv. Bull. No. 13 (n. s.), 1911, p. 63.)

Again, in the Lower Buller Valley for some miles eastward from Hawk's Crag, the conglomerates, grits, and sandstones of the lowest Miocene horizon contain numerous pebbles and grains of coal and carbonaceous shale. In places carbonized fragments of wood, some of which are more or less rounded, are present, so that caution is necessary in considering the origin of individual pieces of coal-like material. There need, however, be no doubt but that the pebbles of carbonaceous shale and most of the coaly fragments are derived from coal-bearing strata, and, unless evidence to the contrary can be obtained, the natural conclusion is that the bituminous-coal measures are the source.

The following analyses show the composition of the fragmental coal in the Miocene rocks:—

—	1.	2.	3.	4.	5.	6.
Fixed carbon	40·70	35·59	39·33	41·96	17·37	29·08
Volatile matter	45·61	47·28	49·00	46·19	29·38	10·82
Water	7·37	5·05	8·15	8·10	4·55	0·66
Ash	6·32	12·08	3·52	3·75	48·70	59·44
	100·00	100·00	100·00	100·00	100·00	100·00
Total sulphur	..	..	0·96	1·46	0·91	0·21
Specific gravity ..	..	..	..	..	..	1·36

1 and 2. Omutumotu Ridge. Samples collected by Geological Survey (probably by A. McKay in December, 1873). Analyses by W. Skey (Lab. Rep. No. 10, 1875, pp. 9–10).
3. Upper part of Kaiata Creek.
4 and 5. Hodge's Creek. Bright coal and impure coal.
6. Pebbles in conglomerate, close to Blackwater Bridge, Buller Gorge Road.

(Analyses 3–6 by Dr. J. S. Maclaurin and staff, Dominion Laboratory.)

From these analyses it appears that the samples, with the exception of that from the Buller Gorge, have a fairly uniform composition. Volatile matter predominates over fixed carbon, and moisture in the purer material averages a little over 7 per cent. The pebbles from Blackwater Bridge consisted of very impure material, and were taken from porous conglomerate, so that weathering may be wholly or in part the cause of the low volatile content. Unfortunately, no other sample from the Buller Gorge has been analysed, and therefore it is not certain that the analysis given is fairly representative of the fragmental coal in that locality.

There are Eocene coal-seams in the Greymouth district similar in composition to samples 1–4, and the more altered portions of the Miocene coal-seams in the Inangahua district also exhibit some resemblance. The latter, however, cannot have been the source of the carbonaceous fragments in the Buller Gorge conglomerates, which are, without much doubt, in a lower horizon. To this statement the thin seams near Hawk's Crag are an exception, since they occur interbedded with the coal-pebble conglomerates.

In general the Oamaru coal-seams are much higher in water than the carbonaceous fragments, and this furnishes another reason why the latter are not likely to have been derived from the former. On the other hand, at the beginning of the Miocene period the Eocene coal-seams had been in existence for a long time, and, according to the writer's belief, had been uplifted or otherwise associated with earth-movements, so that their

chemical composition would probably be much the same as that of the Oamaru brown coals of to-day. During the period that has elapsed since the Miocene, further chemical change has doubtless taken place both in the Eocene coal-seams and in the pebbles derived therefrom.

The extracts from McKay's reports of 1877 and 1901, as well as the writer's own observations, completely dispose of the suggestion that "the coal fragments were wood when entombed in the mud and . . . have been changed into coal *in situ*."* It is true, as already mentioned, that fragments of carbonized wood are associated with coal pebbles in the Buller Gorge conglomerates, but these may nearly always be distinguished from the true coal by their shape, by their more rotten character, and in most cases by distinct traces of woody structure.

Marshall has also suggested contemporaneous erosion of neighbouring coal-seams as a possible cause for the presence of water-worn coal in the Lower Oamaru beds. It has, however, already been stated that the coal-pebble conglomerates of the Buller Gorge are older than the chief Miocene coal-seams, and that the water-worn coal does not agree in composition with them. There is, moreover, no independent evidence of contemporaneous erosion of Oamaru coal-seams, and in any case, at the time when the Omotumotu beds were formed, it is not likely that any Miocene accumulations of vegetable matter were consolidated to a coal sufficiently firm and free from moisture to withstand ordinary erosion and transportation by water without complete disintegration.

Before Eocene coal-seams could be eroded, faulting or folding movements must have elevated portions of the bituminous-coal measures near Greymouth at least 2,000 ft., and more probably 3,000 ft. At Seddonville an elevation of 1,500 ft. might have sufficed. Of an inter-Eocene movement on this scale there is no trace. Certainly there was no defined folding; and though it is just possible that elevation of part of the bituminous-coal measures may have taken place whilst the remainder continued to subside, and was conformably covered by Miocene strata, it is much more likely that the whole area on the west coast of the South Island containing Eocene strata was more or less affected. In any case, it must be admitted that elevation extended from Greymouth to Seddonville, and for some distance north and south of those points. It would then follow that the Miocene rocks in that area rest unconformably upon the Eocene.

B. Discordance in Dip between Eocene and Miocene Rocks.

Ordinarily, discordance of dip between the Eocene and the Miocene rocks cannot be proved, and it is evident that no marked folding of the bituminous-coal measures took place prior to the Miocene in areas where beds of the latter age are now present. In all probability, however, there was block-faulting similar to the faulting that has taken place since the Miocene, and this may have been accompanied by tilting, with the production of relatively steep dips near the fault-planes. Such tilting may be responsible for a discordance in dip observed at Brighton, thirty miles by road south of Westport, where Miocene strata, containing a seam of lignite or brown coal near their base, rest on a breccia or breccia-conglomerate similar to the Hawk's Crag breccia in the Buller Gorge. McKay states that the relations of the lignite beds and the breccia are decidedly uncon-

* Marshall, *op. cit.*, p. 68.

formable, since the former a short distance up the Fox River are nearly horizontal, whilst the breccia in the same locality dips at 35° to the east-north-east.* The unconformity was also observed by J. A. Bartrum in December, 1912.† Since the Hawk's Crag breccia is a slope deposit, it may be maintained that its dip at Brighton is partly or wholly original, and not due to pre-Miocene earth-movement. Even were this admitted, unconformity would still be deducible from the absence of the other members of the bituminous-coal measures.

C. Apparently Unconformable Contacts of Miocene and Eocene Strata.

If it could be clearly shown that Miocene rocks were anywhere deposited on the middle or lower beds of the bituminous-coal measures, or that the upper part of the Miocene in any locality rests on any part of the bituminous-coal measures, unconformity would in ordinary cases be considered as proved. Such unconformable contacts seem to occur in a number of places, but in most cases faulting introduces an element of doubt.

Near the head of Patten's Creek, about two miles west of Seddonville, steeply dipping sandstone, probably of Upper Miocene age, is in contact with Brunner beds. On account of strong faulting here present, unconformity cannot be considered as proved, but the entire absence of the Kaiata beds from the section is significant. On the road to Denniston, not far from Waimangaroa, sandstone, which contains fossils of Upper Oamaru (Blue Bottom) age, is in contact with Kaiata mudstone. The strata, owing to involvement in the great fault zone (Lower Buller or Kongahu fault) at the western base of the Papahaua and Paparoa Ranges, are dipping almost vertically, but only a slight movement is detectable at the actual contact, which therefore practically represents a plane of deposition. Between Waimangaroa and the Buller River, Upper Miocene beds are found in several places close to Eocene strata, but no actual contact has been seen, and in each case the presence of the Kongahu fault renders interpretation doubtful. For this latter reason uncertainty also applies to a contact of bituminous-coal measures with Upper Miocene sandstone, seen at Moran's water-race, two or three miles north-east of Addison's.

At Kotuku, twenty-one miles from Greymouth, below Oamaru strata occurs a conglomerate which lithologically resembles the Brunner conglomerate, and rests upon Aorere rocks. It is quite an open question whether this rock was deposited at the base of the bituminous-coal measures or at the base of the Oamaru series.‡ In the former case there is unconformable contact.

In the eastern part of the Lower Buller Gorge Miocene rocks are found resting on Hawk's Crag breccia, the lowest member of the bituminous-coal measures as developed in the Westport district. Near Hawk's Crag the contact is obscured by faulting, so that details cannot be ascertained. In the valley of Nada Creek, a tributary of the Blackwater River, contact of Miocene and Eocene is again accompanied by faulting, but at one spot in the bed of a small brook (Lily Creek) Miocene sandstone rests on an irregular, apparently eroded surface of breccia. The exposure, however, is so small that it must be deemed unsatisfactory, more particularly since the

* "Reports relative to Collections of Fossils made on the West Coast District, South Island." Rep. Geol. Surv. during 1873–74, No. 8, 1877, p. 109.

† Personal communication.

‡ See N.Z. Geol. Surv. Bull. No. 13 (n.s.), 1911, pp. 67, 138.

identification of the breccia as the Hawk's Crag rock could be questioned. Elsewhere actual contacts have not been located, but the complete absence of the Brunner and the Kaiata beds from the Buller Gorge section in itself appears to prove unconformity. McKay in 1895 speaks of the brown-coal series resting on the breccia with some appearance of unconformity,* and at an earlier date describes a probable unconformity in the rocks of the Buller Gorge.† Apparently, however, he supposes that the stratigraphical break is immediately below the brown-coal horizon, and therefore above the conglomerates containing coal pebbles.

It would seem that the Buller Gorge section in itself proves unconformity between Eocene and Miocene, unless it can be shown that the Hawk's Crag breccia does not belong to the bituminous-coal measures. The peculiar nature of the breccia, however, leaves a loophole for doubt. As already mentioned, it is a slope deposit, and was possibly formed far above sea-level, so that the contacts with Miocene rocks at Brighton and in the Buller Gorge may perhaps be cases of overlap rather than indications of true unconformity.

D. Overlap of Miocene Rocks on the Pre-Tertiary Land-surface.

In many places the Oamaru rocks of the west coast of the South Island are found to rest on the pre-Tertiary land-surface at points only a short distance from bituminous-coal measures. Thus at Kongahu Point and for some miles southward they rest on granite, at Cape Foulwind and Charleston on gneiss, and at Inangahua Junction on greywacke and argillite penetrated by granitic dykes. In Stillwater Creek Valley, at a spot about three miles south of Brunner, is a small outcrop of greywacke surrounded by Miocene rocks. At Kotuku, near Lake Brunner, boring for petroleum has shown that Miocene strata either rest on Aorere rocks or, as previously mentioned, are separated from the latter only by the basal conglomerate of the bituminous-coal measures.

In the Collingwood district similar overlap of Miocene strata on pre-Tertiary rocks near bituminous-coal measures is found,‡ and probably the extension of detailed geological surveys through Central Nelson will furnish other examples.

The deposition of Oamaru strata on a pre-Tertiary surface in localities many miles from known outcrops of the bituminous-coal measures may easily be explained as cases of overlap, and therefore it is not necessary to describe such occurrences. Since, however, the marine beds of the Eocene succession are from 1,500 ft. to 3,000 ft. in thickness, the overlap of Miocene beds on a pre-Tertiary land-surface not far from areas of the bituminous-coal measures is strongly significant. Though in a fault-rent country like New Zealand strong overlaps do not necessarily prove an unconformity, they at least furnish confirmatory evidence of its existence.

III. The Pre-Eocene Unconformity.

Owing to the somewhat uncertain age of the Greenland series, the lower time-limit of the unconformity between these supposed Aorere rocks and

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* "Geology of the South-west Part of Nelson and the Northern Part of the Westland District." Mines Report, 1895, Parliamentary paper C.–13, p. 7.

† "Reports relative to Collections of Fossils made on the West Coast District, South Island." Rep. Geol. Surv. during 1873–74, No. 8, 1877, pp. 103, 104, 105.

‡ Park ("The Geology of New Zealand," 1910, pp. 310–11) says that the upper coal-measures conformably follow the bituminous-coal measures, a statement which is, of course, opposed to the trend of this paper.

the Eocene coal-measures is doubtful; but, in any case, the interval of time represented is long. The general evident discordance in strike and dip, together with the great difference in lithological characters between the Palaeozoic and the early Tertiary rocks, renders recognition of the unconformity an easy matter. Probably—in fact, certainly—some deposition of sediments took place between the Ordovician and the Eocene in the North Westland and Westport districts; but of this there is no direct evidence, all traces of such beds having been removed by pre-Eocene erosion. At Reefton, however, near the districts discussed, Devonian strata are found, and Trias-Jura rocks appear on the eastern side of the Southern Alps.

It is noteworthy that though over considerable areas the bituminous-coal measures were deposited on a nearly flat surface, yet in places the overlap of the higher beds on the pre-Tertiary old land is considerable. The nature of the basal conglomerate, and more especially of the Hawk's Crag breccia, is further evidence of an irregular land-surface at the beginning of the Eocene. Although the Kaiata beds, the uppermost member of the bituminous-coal measures, have nowhere been observed to thin out owing to overlap, yet in many places Eocene strata are absent, and Miocene beds are found resting on pre-Tertiary rocks. The question of whether this increased extent of the pre-Eocene unconformity is due wholly to overlap, or in part to erosion of the bituminous-coal measures, has already been discussed, and decided in favour of the latter supposition.

SUMMARY AND CONCLUSIONS.

The evidence of unconformity at two horizons, one pre-Tertiary and the other post-Miocene, is clear and unmistakable. In the case of a third unconformity—that between the Eocene and the Miocene—certainty is wanting, but the available data strongly favour a stratigraphical break. In view of the importance of the matter from an economic point of view, it may be as well roughly to summarize the evidence both for and against this pre-Miocene unconformity, and to leave the reader either to form his own conclusion or, if he pleases, to preserve an open mind. Unconformity is supported by the occurrence in Miocene rocks of water-worn pebbles of coal and of carbonaceous shale almost certainly derived from Eocene coal-measures; by marked discordance of dip between Miocene strata and Hawk's Crag breccia at Brighton; by a number of apparently unconformable contacts between Eocene and Miocene strata; and by the strong overlap of the Miocene rocks on the pre-Tertiary land-surface.

On the other hand, it is just possible that the coal pebbles are a product of contemporaneous erosion; that the discordance in dip between Miocene and Eocene rocks at Brighton has another explanation; that the apparently unconformable contacts between Eocene and Miocene strata can be explained by faulting or in some other way; and that the strong overlap of the Oamaru rocks on the pre-Tertiary land-surface is wholly due to the bold relief of the land at the beginning of the Eocene, and not at all to unconformity between two Tertiary formations.

Though the evidence for a stratigraphical break may not be regarded as conclusive, it is mainly of a positive character, whilst the opposing evidence is largely negative. It is practically certain that considerable earth-movements took place after the formation of the bituminous-coal seams and before the deposition of the Oamaru series. The point in doubt

is whether these movements were so far concentrated at any time as to produce unconformity. The failure to obtain conclusive evidence may be attributed mainly to the rough bush-clad nature of the country explored, which rendered difficult any access to several localities where Eocene and Miocene strata are in contact, and where, therefore, important data might have been obtained. Careful examination of a wider area, however, may be expected to yield definite results.

Art. XXXVI.—*List of Fossil* Mollusca *from Bluecliffs, South Canterbury.*

By M. C. Gudex, M.A., B.Sc.

[*Read before the Philosophical Institute of Canterbury, 1st October, 1913.*]

These fossils were collected from the bluish clays in the Upper Otaio Valley, near Bluecliffs Station, and were all identified by Mr. H. Suter. In addition to the following list, some ten new species are yet to be described.

Turritella carlottae Watson.
—— *rosea* Q. & G.
—— *cavershamensis* Harris.
—— *patagonica* Sow.
—— *concava* Hutt.
Calyptraea maculata Q. & G.
—— —— *inflata* Hutt.
Natica zelandica Q. & G.
Polinices cinctus Hutt.
—— *amphialus* Watson.
—— *suturalis* Hutt.
—— *huttoni* Ihering.
—— *ovatus* Hutt.
—— *planispirus* Sut.
Ampullina undulata Hutt.
Cymatium minimum Hutt.
Galeodea senex Hutt.
Epitonium rugulosum lyratum Zitt.
—— *browni* Zitt.
Fusinus spiralis A. Ad.
Exilia dalli Sut.
Siphonalia dilatata Q. & G.
—— *costata* Hutt.
—— *conoidea* Hutt.
Vexillum rutidolomum Sut.
Alectrion socialis Hutt.
Typhis maccoyi T.-Woods.
Fulguraria (Alcithoe) aculeata Hutt.
—— *arabica* Martyn.
Lapparia corrugata Hutt.
Ancilla pseudaustralis Tate.
—— *hebera* Hutt.
—— *bicolor* Gray.
Drillia awamoaensis Hutt.
Surcula fusiformis Hutt.
Bathytoma sulcata Hutt.
—— *haasti* Hutt.
Terebra pareoraensis Sut. (= *T. nitida* Hutt., *non* Hinds).
—— *orycta* Sut.
Dentalium solidum Hutt.
—— *ecostatum* Kirk.
—— *mantelli* Zitt.
Malletia australis Q. & G.
Placunanomia zelandica Gray.
Arca (Cucullaria) australis Hutt.
Limopsis aurita Brocchi.
Pecten huttoni Park.
Lima colorata Hutt.
Atrina zelandica Gray.
Crassatellites obesus A. Ad.
Venericardia australis Lam.
Dosinia greyi Zitt.
Chione chiloensis Phip. subsp. *truncata* Sut.
—— *meridionalis* Sow.
Corbula canaliculata Hutt.
Panopaea orbita Hutt.
Teredo heaphyi Zitt.

ART. XXXVII.—*Localities for Fossils near Oamaru.*

By P. MARSHALL, M.A., D.Sc., F.R.G.S., Professor of Geology, Otago University, and G. H. UTTLEY, M.A., M.Sc., F.G.S., Waitaki High School.

[*Read before the Otago Institute, 2nd December, 1913.*]

IN a paper read before the Otago Institute last year we gave lists of fossils that we had collected at different localities near Oamaru. Since that time we have had further opportunities of collecting, and we now place before the Institute the results of this further work. The list previously given from the Target Gully beds has required much alteration in view of the more perfect specimens that we have obtained, and consequently more satisfactory and exact identification has been possible. Many additional species have also been obtained, especially of the more diminutive molluscs. Mr. H. Suter, of Christchurch, again has most kindly identified the great majority of our specimens, and has also corrected a few of the identifications that we had made previously. Without making special mention of the additions and alterations the list now becomes as follows :—

Emarginula striatula Q. & G.
Schismope n. sp.
Trochus tiaratus Q. & G.
—— n. sp.
Turritella carlottae Watson.
—— *concava* Hutton.
—— *rosea* Q. & G.
—— *murrayana* Tate.
Monilea n. sp.
Struthiolaria papulosa Martyn.
—— *cincta* Hutton.
Lissospira n. sp.
Calyptraea maculata Q. & G.
—— *alta* Hutton.
—— *maccoyi* Suter.
Crepidula crepidula L.
—— *densistriata* Suter.
—— *striata* Hutton.
—— *costata* Sowerby.
—— *incurva* Zittel.
Circulus n. sp.
Cerithiopsis n. sp.
Erato n. sp.
Eglisia n. sp.
Turbonilla n. sp.
Odostomia n. sp.
Leptothyra fluctuata Hutton.
Natica zelandica Q. & G.
Polinices suturalis Hutton.
—— *gibbosus* Hutton.
Epitonium browni Zittel.
—— *lyrata* Zittel.
Ringicula uniplicata Hutton.
Siphonalia conoidea Hutton.
—— *turrita* Hutton.
Siphonalia dilatata Q. & G.
—— *costata* Hutton.
—— n. sp.
Cominella lurida Phil.
—— n. sp.
Volvulella reflexa Hutton.
Cymatium cfr. *minimum* Hutton.
Murex octogonus Q. & G.
Trophon cfr. *plebeius* Hutton.
—— *paivae* Crosse.
Typhis maccoyi T.-Woods.
Alectrion socialis Hutton.
—— n. sp.
Latirus brevirostris Hutton.
—— n. sp.
Fulguraria arabica Hutton.
—— —— *elongata* Swainson.
Lapparia corrugata Hutton.
Mitra n. sp.
Vexillum n. sp.
Ancilla australis Sowerby.
—— *pseudaustralis* Tate.
—— *bicolor* Gray.
—— *hebera* Hutton.
—— n. sp.
Bathytoma sulcata Hutton.
—— n. sp.
Marginella harrisi Cossmann.
—— *conica* Harris.
Surcula fusiformis Hutton.
—— *awamoaensis* Hutton.
Drillia n. sp.
Turris altus Harris.
Admete sp.
Daphnella n. sp.

Mangilia n. sp.
Borsonia n. sp.
Terebra orycta Suter.
Cylichnella striata Hutton.
—— *enysi* Hutton.
—— n. sp.
Dentalium mantelli Hutton.
—— *solidum* Hutton.
—— n. sp.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Placunanomia incisura Hutton.
—— *zelandica* Gray.
Anomia huttoni Suter.
Arca decussata Q. & G.
—— *australis* Hutton.
—— n. sp.
Limopsis zitteli Ihering.
Glycymeris laticostata Q. & G.
—— *globosa* Hutton.
—— n. sp.
Cucullaea alta Sowerby.
Pecten zelandiae Gray.
—— *burnetti* Hutton.
Pseudamusium huttoni Park.
Lima colorata Hutton.
Mytilus striatus Hutton.
Ostrea angasi Hutton.
Ostrea nelsoniana Zittel.
Crassatellites obesus A. Ad.
—— *attenuatus* Hutton.
—— *amplus* Zittel.
Venericardia difficilis Deshayes.
—— *pseutes* Suter.
Diplodonta globularis Lam.
Tellina glabrella Deshayes.
Zenatia acinaces Q. & G.
Dosinia magna Hutton.
Macrocallista n. sp.
Chione meridionalis Sowerby.
—— *mesodesma* Q. & G.
—— *yatei* Gray.
Paphia curta Hutton.
—— n. sp.
Cytherea oblonga Hanley.
—— *sulcata* Hutton.
—— *subsulcata* Suter.
Psammobia lineolata Gray.
Corbula pumila Hutton.
—— *canaliculata* Hutton.
—— *humerosa* Hutton.
—— *caiparaensis* Suter.
Myodora subrostrata E. A. Smith.
Panopea sp.
Chama huttoni Hector.
Chamostrea albida Lam.

Of these 126 species, Mr. Suter is good enough to inform me, forty-six are Recent. The percentage of Recent species is therefore 36·3. Mr. Suter informs me that 50 per cent. of the species listed in the paper published last year are Recent. This shows how very greatly this percentage may change as the collection from a locality becomes more complete. It is hoped that during the ensuing year we may be able to excavate the bed to such an extent as to make the collection still more complete. At the present time greensands are exposed in a small cutting about 50 ft. below the actual shell-bed.

The fact that this list of 126 species includes some thirty species that Mr. Suter considers to be new shows how very imperfectly the Tertiary beds of New Zealand have been scrutinized. Under these circumstances, it is obviously quite unsatisfactory to attempt to classify the Tertiary strata on the basis of the absence of any species in some strata or because of their presence in others. Several of the genera recorded here have not previously been found in the fossil state in strata below the Wanganui beds, of Pliocene age, and Hutton even states* that the Pliocene is distinguished from the Miocene by the occurrence of such genera as *Trophon*. I can find no record of species of *Circulus*, *Schismope*, and *Cerithiopsis* being found in the fossil state in New Zealand.

Mr. Suter has kindly undertaken to describe the new species in Palaeontological Bulletin No. 3 of the Geological Survey, which will be published shortly.

* Macleay Memorial Volume.

ART. XXXVIII.—*Notes on the Geology of Moorea and Rurutu Islands.*

By P. MARSHALL, M.A., D.Sc., F.R.G.S., Professor of Geology, Otago University.

[*Read before the Otago Institute, 4th November, 1913.*]

THE island of Moorea, or Eimeo, appears to have been first visited by Captain Cook in the year 1777, though it had been discovered by Captain Wallis ten years previously, and named by him Duke of York Island. Cook anchored in the harbour called by him Taloo, on the northern side of the island. This harbour is now called Papetoai, while another similar bay, also on the north side of the island, is often called Cook's Bay, though the great navigator never actually took his ships into it. Though Cook did not visit the island before 1777, he had during his first voyage sent one of his boats, under the charge of Lieutenant Gore, to make observations on the occasion of the transit of Venus in 1769. Cook himself made similar observations at Point Venus, in Tahiti. Lieutenant Gore reported that he had been well received by the Natives, though he regarded the island as not very fruitful.

Apparently the next vessel to visit the island was the ship "Duff," under the charge of Captain Wilson, during the missionary voyage to the South Seas. A plate showing the appearance of Taloo Bay is given on page 83, "Missionary Voyage to the South Seas" (Wilson, 1799).

In Cook's Voyages the rocks are said to be bluish, with little particles of mica. In Wilson's Voyage the only reference that I can find to geology is the following: "The island appears to have suffered great convulsions, either from earthquakes or from other violent causes. Most of the hills are high, with broken rugged sides, particularly about Taloo Harbour, from the entrance of which they have a very striking appearance."

Ellis, in his "Polynesian Researches" (vol. 1, p. 18), says, "In the varied forms its mountains exhibit, the verdure with which they are clothed, and the general romantic and beautiful character of its scenery, this island surpasses every other in the Georgian or Society Groups."

These extracts give a vivid and an exact idea of the highly picturesque appearance of the island. The remarkable effects of subaerial erosion in forming the pinnacled peaks, the piercing shape of the aiguilles and the precipitous sides of the valleys have excited the wonder and admiration of all geologists who have visited these tropical islands of the Pacific Ocean.

As is the case in Tahiti, Rarotonga, and in all of the high islands of the eastern Pacific, Moorea is entirely formed of volcanic rocks, but all indications of the form of the original volcano have been lost. The lava and scoria slopes of the volcanoes have been cut up by the erosive action of the tropical rains and torrents into steeple-shaped peaks, separated by the most profound valleys, with sides so steep that they cannot be scaled.

Moorea is triangular in shape, each side of the triangle being about eight miles in length. It is surrounded by a continuous coral reef about a mile distant from the shore, and on it islands are situated here and there. It appears that up to the present time no detailed information has been available in regard to the rocks of which it is composed.

The only place that I was able to visit was the Bay of Putoa, on the south-east side. At the head of this bay is the village of Afareaitu, one of the early missionary settlements—where, in fact, the first printing-press in the South Sea Islands was installed, in the year 1817.

A narrow strip of flat land separates the hills from the beach. This is formed mainly of the gravel brought down by the two small streams from the pinnacled mountains a little more than a mile distant. The gravel-flat extends a little distance back into the valleys, which appear to have been formed when the land stood at a higher level. The rock at the lower end of the spurs is a basalt, which, though generally fine-grained, contains relatively large crystals of olivine. The stones in the bed of the small stream are, however, phonolite of a trachytoid nature, and they evidently come from lava-flows at relatively high levels. High up on the hills are to be seen outcrops of massive lava-flows with the same colour and the abrupt appearance that is so characteristic of the phonolitic rocks in Raiatea and Huaheine. When seen in thin section this rock is found to be composed of small microlites of feldspar. Between these there can occasionally be seen a few minute crystals of nepheline, though in much smaller quantity than in the corresponding rock from Huaheine.* Aegerine augite is quite plentiful, and it has an extinction-angle of 40°. A good deal of magnetite is present.

The island of Rurutu, one of the Tubuai group of islands included in the French possessions in the Pacific Ocean, lies in latitude 22° 27′ S. and 151° 21′ W. longitude. It is six miles long and three miles long, and rises in a sharp peak to an elevation of 1,300 ft. The island was discovered by Cook in 1769, and Tupia, who was then a passenger in Cook's ship, called it Ohiteroa. It is, however, noticeable that in Tupia's map of the South Sea Islands published in Forster's "Observations made during a Voyage round the World" Rurutu is the name given to an island placed in a group including O Rimatarra and O Reevavai, which are obviously intended for the islands now known as Rimatara and Raivavae. This group is, however, in his map placed to the north-west of Tahiti, whereas it actually lies some three hundred miles to the south of that island. Rurutu seems to be the name that is almost universally used for this island, and, seeing that it is the name used by Tupia himself for the island in his map, it appears to be probable that he mistook this island for some other when it was first sighted.

The reef that surrounds the island is almost in touch with the shore, and it is not penetrated by any good passages. So far as the geology of Rurutu is concerned, the only statement that I can find is that of Ellis, who says that there is limestone on the island, and that garnets have been found there.

I am indebted to Mr. Fred. Hildreth, of Gowgonda Lake, Ontario, Canada, for specimens of rock from this island, and for much information in regard to it. On the eastern side of the island there is a good deal of calcareous conglomerate with much included volcanic rock. This formation rises to a level of 300 ft., and has a highly irregular surface. Above this level the surface of the ground consists of highly coloured clays, obviously derived from the decomposition of basic volcanic rock. This is apparently a coarse-grained doleritic rock, which in hand-specimens appears

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* Marshall: "Alkaline Rocks of the Cook and Society Islands," Trans. Aust. Assoc. Adv. Sci., vol. 13, 1912, p. 198.

to closely resemble the coarse dolerite that is so common in Rarotonga, Tahiti, Huaheine, and Raiatea. Unfortunately, I could not obtain a specimen of this rock for microscopic examination. On the west side of the island the material at the sea-level is a fine-grained igneous rock similar to the fragments contained in the calcareous agglomerate on the eastern side. This rock contains enough magnetite to deflect the compass-needle in the most marked manner. Under the microscope it is found to contain relatively large crystals of magnetite embedded in a very fine-grained groundmass consisting largely of minute microlites of labradorite feldspar, some very small crystals of olivine, minute granules of augite and of magnetite. Though extremely fine-grained, there is no glass whatever in the rock, which has evidently been formed from the very rapid cooling of basaltic lava.

From the statements made to me by Mr. Hildreth, combined with the results of my examination of the rock-specimens, the following appears to be the geological history of the island: Submarine volcanic action first formed the agglomerate on a sea-floor that was covered with calcareous ooze. The eruptions continued, and formed a volcano of moderate size. The old sea-floor was afterwards raised until it attained an elevation of 300 ft. above sea-level. There is apparently a well-marked terrace at an elevation of about 300 ft. on the east side, which probably marks a sea-level that remained unchanged for a considerable period.

ART. XXXIX.—*The Geology of the Cape Runaway District.*

By P. MARSHALL, M.A., D.Sc., F.R.G.S., Professor of Geology, Otago University.

[*Read before the Otago Institute, 2nd December, 1913.*]

THE strip of country running due east and west from Cape Runaway to Matakaoa Point has not yet received much attention from the geological standpoint. Throughout this twenty miles of coast-line the country rises steeply, and soon reaches to an elevation of 1,300 ft. The country slopes down nearly as steeply on the southern side of the ridge into the valleys of the Wharekahika and Ngarue Streams, running east and west respectively. Thus this narrow bar of country is marked off from all that lying to the south, and constitutes a physiographical unit. In a north-north-east direction the ocean-floor dips down steeply, and within fifty miles there is a depth of 1,000 fathoms, and within two hundred miles the ocean is 4,380 fathoms deep. This profound abyssal depth marks the farthest known extension of that great earth-feature the Kermadec-Tonga trench; but, since soundings are relatively few in this part of the Pacific Ocean, it is quite possible that future work will show that this trench actually extends still farther to the south. This is the nearest known approach of abyssal depths to the coast-line of New Zealand. The average slope throughout this distance of two hundred miles is about 137 ft. per mile—that is, 1 in 40.

Although this small patch of country has never received much attention from geologists, it has generally been recognized that the rocks of which it is composed are of a different nature from those of the country that lies to the south. The rocks that are in contact with those which are now being considered are of the Oamaru system of marine sediments. Farther to the southward, if one may judge from the nature of the pebbles that are found in the gravels of all the tributary streams of the Wharekahika Stream, the Oamaru sediments are soon succeeded by the Maitai sediments of Trias-Jura age.

The following are the references that have been made to this country in previous geological work :—

1869 : Hector's geological map of New Zealand represents them as formed of Cretaceo-Tertiary sediments.

1873 : McKay, Geological Report, p. xvi.—The map indicates the occurrence of trachytic conglomerates throughout this area.

1873 : Hector's geological map of New Zealand. — Coal-measures, Cretaceous to Miocene.

1877 : Cox, Geological Report, p. 112. — Trachytes and trachytic agglomerates : "The trachytes in solid flows may be observed continuously until passing Matakaoa Point, Hicks Bay, where they pass by degrees into coarse angular conglomerates." He thinks that the centre of eruption in all probability lay to the seaward of the present coast-line. "They appear to me to be of the same age as the trachytes of Whangarei Heads (andesites), which they resemble in a marked degree, and as they are overlaid by the oyster-bed, which is the lowest member of the Tawhiti series as here developed, they must be at least of Upper Eocene age."

1883 and 1885 : Hector's geological map of New Zealand.—Palaeozoic sediments.

1887 : McKay, Geological Report, p. 184. — This geologist went by sea from Whangaparao to Awanui. He did not see these rocks, but on his map on page 192 he indicates them as acidic volcanic rocks.

1907 : Marshall, Trans. Aust. Assoc. Adv. Sci., p. 376, states that he has not examined any rocks from this district, but in the map indicates them as basalts.

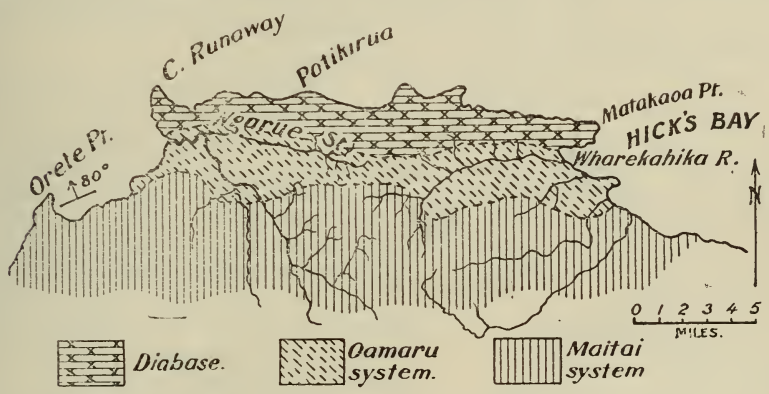
1910 : Park, "Geology of New Zealand."—In the geological map this area is coloured as though formed of acidic volcanic rocks.

1912 : Marshall, "Geology of New Zealand."—In the geological map the area is tinted the same as those that are formed of basalts and andesites.

This brief *résumé* shows that the rocks have never been accurately examined. An opportunity of visiting the district occurred in February, 1912. Specimens were then collected from the south side of Hicks Bay and from the valley of the Wharekahika River, as well as the coast-line near Cape Runaway. Mr. E. de C. Clarke also kindly gave me specimens that he had collected from the coast-line at Potikirua and Arerotepa. The specimens from the valley of the Wharekahika River and Cape Runaway were not *in situ*, but all the others were. On the south side of Hicks Bay the volcanic rocks are interstratified with the limestone of Tertiary age, and they evidently represent the products of volcanic activity in relatively deep water, judging from the nature of the associated limestone and by the absence of oxidized material and of steam-pores in the fragmentary matter. Tuff and scoriaceous material is interstratified with the limestone.

All the specimens collected show a great similarity in composition and structure. There are two distinct types, holocrystalline and glassy. The glassy type is formed almost entirely of a dark-brown glass with incipient crystallization in black semi-opaque patches. There are no crystals or microlites present.

The holocrystalline rocks are somewhat diabasic in structure, often ophitic, with relatively little olivine, which is nearly completely changed into serpentine. The feldspar is mainly labradorite much decomposed. The augite is nearly colourless, and is always allotriomorphic. Iron-ore is plentiful, apparently entirely ilmenite. These two types closely resemble those that are found at Oamaru, where also they are interbedded with the limestone of Tertiary age. They have been described by Hutton.* Hutton† also describes several other glassy types of a similar nature. He afterwards states that the rocks occur interstratified with sedimentary rocks of Oamaru age at intervals from Look-out Point, near Hampden, to Castle Hill, a distance of 150 miles.‡ McKay and Sollas describe similar types from the



Mason River, in South Nelson, where again they are interstratified with limestone rocks of Oamaru age.§ It thus appears that over a wide extent of the eastern coast-line of New Zealand submarine eruptions of a basic nature occurred at the time when the limestone of Oamaru age was undergoing deposition. It has been suggested in another paper that the limestone of this series was deposited approximately at the same time throughout New Zealand, and that it was laid down when the country had reached its maximum of physical depression.|| If this be the case, it is evident that this widespread series of submarine eruptions was practically simultaneous, and ushered in a period of general epeirogenic elevation in the New Zealand region.

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* Trans. N.Z. Inst., vol. 19, 1886, p. 417.
† Jour. Roy. Soc. N.S.W., 1889, p. 152.
‡ Trans. N.Z. Inst., vol. 32, 1899, p. 170.
§ "Rocks of Cape Colville Peninsula," vol. 2, p. 168.
|| Trans. N.Z. Inst., vol. 43, 1910, p. 404.

Art. XL.—*Preliminary Note on the Uplifted East Coast of Marlborough.*

By C. A. Cotton, M.Sc., Victoria College, Wellington.

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

Plate XI.

Introduction and General Statement.

The previous record of uplifts along the coast of Marlborough and its continuation towards Canterbury is limited, so far as the writer is aware, to the mention by Hutton* and McKay† of raised shore-terraces at a few points on the coast, and the description of cut platforms northward of the mouth of the Waipara River by Speight.‡

There are three cut platforms on Kaikoura Peninsula, the highest of which forms the flat top of the peninsula at a height of 330 ft., and there is a small remnant near Cape Campbell. In comparison with other evidence, that afforded by raised shore-lines is, however, remarkably slight for the greater part of the length of the coast of Marlborough.

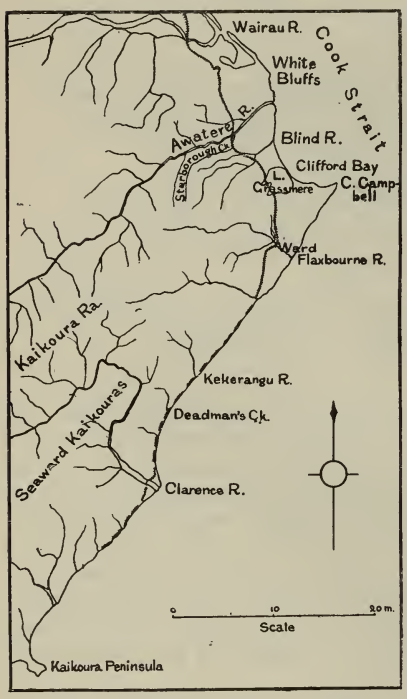

Fig. 1.—Locality Map of Eastern Marlborough.

In Marlborough there are also other unequivocal proofs of uplift of two kinds—namely, (1) rejuvenation of topography, and (2) the presence of an uplifted delta. Notes on these are presented in this paper, and also on (3) residuals of a slightly elevated wave-cut platform near Flaxbourne that have previously escaped notice, and (4) a long strip of strand-plain of recent origin which points also to uplift as its probable cause.

No pretence of completeness of treatment can be made, as the writer's observations, though spread over a considerable period, were made during the course of other work; and no conclusion can at present be arrived at on the important questions whether the uplift has been uniform throughout the region examined or is of the nature of warping, whether it is entirely distinct from, or a posthumous continuation of, the orogenic movements by which the Kaikoura Ranges were formed,§ and what is the relation of the uplifted area to the neighbouring downthrown areas—namely, those lying off the east coast and in Cook Strait, and also the Marlborough Sounds district.

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* F. W. Hutton, Geol. Surv. of N.Z., Rep. Geol. Expl. during 1873–74 (1877), p. 55.
† A. McKay, *ibid.*, 1874–76 (1877), p. 177.
‡ R. Speight, Trans. N.Z. Inst, vol. 44 (1912), pp. 223–24.
§ See C A. Cotton, Geogr. Journ., vol. 42 (1913), p. 227.

With regard to the last point, however, it may be noted that, while along the greater part of the length of the eastern coast subsidence of the region to the east almost certainly preceded the uplifts here recorded, for a short distance southward of Kaikoura off-shore subsidence was more recent, resulting in the formation of a strip of fresh fault coast. The writer hopes to describe this fault coast in another paper. The boundary between the depressed Marlborough Sounds area and uplifted eastern Marlborough is obscured by the flood-plain of the Wairau River, though possibly it may be seen in the Upper Wairau Valley.

It may be here noted that, while there is proof that in early Quarternary times the region stood much lower than at present, no evidence has been observed by the writer in eastern Marlborough of a Pleistocene movement of depression* of any consequence.

It would seem that the Kaikoura orogenic movement was followed by a period of rest, and that afterwards the discontinuous movement of uplift began, which is still in progress. It may be true that during the course of this uplift there have been some downward oscillations; but, if so, they must be of relatively slight importance in the geological history.

1. REJUVENATED TOPOGRAPHY.

The Weak Rocks.

Along the shore of Cook Strait, from the mouth of the Awatere River to Clifford Bay, unconsolidated mudstones and sandstones form the coast. The lower valleys of the Awatere River and the neighbouring smaller streams, the chief of which is the Blind River, are excavated in these beds, which extend up the Awatere a distance of twenty-five miles. The rocks of this area are generally known as the Awatere beds, and are of Tertiary (some of them certainly of late Tertiary) age. The extent of this area of very weak rocks is shown in fig. 2.

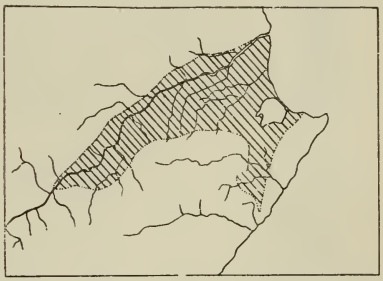

FIG. 2.—MAP SHOWING THE AREAL DISTRIBUTION OF THE AWATERE BEDS (AFTER MCKAY).

A strip of lithologically similar rocks† (nearly all mudstone) forms Cape Campbell and the coast for some distance southward, and there is a considerable area of similar weak mudstone† at the mouth of the Kekerangu River and southward to the mouth of the Clarence. Here the beds stand in a nearly vertical altitude; in the lower Awatere Valley, on the other hand, they lie nearly horizontally or dip at low angles. The topographic forms developed by erosion are, however, independent of the dip and strike, for the rocks are uniformly very weak, and are in this respect in marked contrast with all the other rocks of the Marlborough coast. In a period barely sufficient to allow streams working on moderately resistant rocks to grade their channels the surface of these beds is reduced to mature or even senile relief, and their topography consequently preserves admirably the history of a rapid succession of movements of uplift separated by pauses. Erosion would, however, during a relatively prolonged period of standstill efface the whole record.

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* See P. Marshall, "New Zealand," "Handbuch der regionalen Geologie," vii, 1, p. 47.

† Not necessarily of the same age as the Awatere beds.

The Awatere Area.

A view up the Awatere Valley from a point near the railway bridge shows a succession of broad and high terraces. It seems probable that an accurate survey of the terraces would show that some of them can be correlated on both sides of the river as remnants of dissected flood-plains that mark stationary episodes in a movement of uplift; while, on the other hand, there can be no doubt that a number of the terrace remnants have no such significance, but have a merely local development, and simply mark lateral swings of the river-channel during down-cutting.

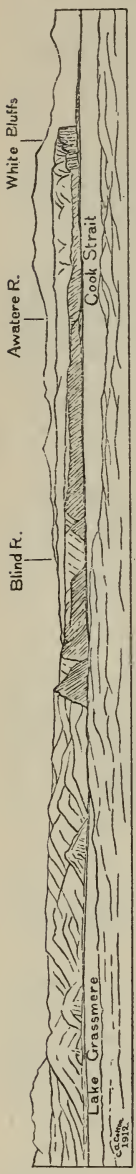

Fig. 3.—View looking North-west from the East Side of Lake Grassmere, showing the Cliffed Margin of the 350 ft. Surface.

The ridge in the background, forming the divide between the Wairau and Awatere Rivers, shows also an even sky-line sloping down to a height of about 900 ft. near White Bluffs.

It will here suffice to refer to the highest of the valley-floor remnants noted and to some lower series of terraces that indicate prolonged standstills. The highest patch of superficial gravel noted by the writer in the lower valley occurs on the top of an isolated, rounded hill, 964 ft. high, situated about two miles south-west of the Awatere railway bridge. The top and flanks of the hill are thickly covered by fluviatile gravel consisting of pebbles of clastic and igneous rocks similar to those in the bed of the Awatere River to-day. The rock composing the hill being a weak mudstone, the surface of which has been sculptured to mature outlines during later erosion periods, its top does not preserve a flat remnant of the ancient flood-plain, the height of which above present sea-level must, therefore, have been somewhat greater than the present height of the hill. The height at this point, above present sea-level, of the bed of the ancient Awatere, which was no doubt the stream that spread the gravel, may be taken to be about 1,000 ft. Opposite this point the river is now about 200 ft. above sea-level. In the present cycle it is a submature, steep-grade stream, whereas in the ancient cycle in which the high-level gravels were laid down it may have been fully mature and may have had a flatter grade; but, on the other hand, the mouth may have been farther seaward. It is, therefore, difficult to estimate the height above sea-level at which the gravel was originally deposited, but it was probably not more than 200 ft., and its presence where it is now found may be taken to indicate elevation of 800 ft. Farther up the valley of the Awatere terrace remnants are much higher above present sea-level, but their distance from the mouth of the river renders them of little value in estimating the amount of uplift.

Flat-topped interfluves that appear to be remnants of a surface of senile relief developed over a considerable area during a later pause in the movement of uplift are now prominent on the seaward portion of the Awatere

area. McKay* notes the presence of Awatere River gravels on low hills in this vicinity. This ancient surface, now dissected, but indicated by an even sky-line (see fig. 3), slopes gently seaward, and apparently two trigonometrical stations, at heights of 352 ft. and 355 ft., close to the edge of the cliffs bordering Cook Strait, are situated on it. Some flat-topped remnants near the south-east bank of the Awatere River, at a distance of about three miles from the sea, reach a height of 543 ft., but the writer failed to note whether they are accordant with the last-mentioned surface or stand above it.

During a later—the last—long pause in the general movement of uplift fairly broad valley-floors were cut by the Awatere and neighbouring smaller rivers upon the weak rocks. In the vicinity of the railway bridge the broad terrace plains on either side of the Awatere River, remnants of the flood-plains of this period, together have a width of three miles, and are at a height of 290 ft. above sea-level and 120 ft. above the present level of the river.

The river now wanders in braided channels on the gravel-covered floor of a trench a few hundred yards in width. Such braided courses are now a common feature of New Zealand rivers, and, of course, indicate excess of waste supply over transporting-power, resulting in aggradation. In the writer's opinion, the present excess of waste in Marlborough is largely, if not wholly, the results of destruction of the original vegetable covering of the land as a result of settlement. The excessive supply of waste more than balances the effect of a very recent, small movement of uplift in Marlborough, which will be mentioned later, and which, other things being equal, would have resulted in degradation. The writer has been informed by E. A. Weld, Esq., of Flaxbourne, that the bed of the Flaxbourne River has been perceptibly raised, and it is said of the Kekerangu River, which now flows in braided channels on a broad gravel bed, that in the early days of settlement it was a "swamp stream"—that is, had a marshy flood-plain. Speight regards the cause of similar aggradation in Canterbury rivers as climatic.†

With respect to present sea-level as base-level the lower course of the Awatere is graded, but its declivity is still steep, being something like 25 ft. or 30 ft. per mile. The vertical concave banks and the convex banks descending gradually as series of terraces indicate that the curves of the stream have been enlarged contemporaneously with down-cutting. Considered in connection with the extreme weakness of the rocks in which the river is working, the youth of the present valley indicates that the latest important uplift—that is, the one that interrupted the last long plain-cutting pause—took place very recently. Tributary streams flow for long distances over the surface of the uplifted flood-plain, and rejuvenation has reached but an insignificant distance from their mouths. An example of these is Starborough Creek,‡ which enters the Awatere on the south-east side, a short distance below the railway bridge.

In the neighbourhood of Flaxbourne (or Ward) there is similar proof of pauses in the general movement of uplift, the pauses being sufficiently long there also to allow of the excavation of extensive valley lowlands by the local streams where these flowed over the weak Awatere beds. In places the intervening ridges were cut right through, continuous lowlands

* A. McKay, Geol. Surv. of N.Z., Rep. Geol. Expl. during 1885 (1886), p. 125.

† See footnote to p. 294.

‡ This tributary, flowing for about five miles over the surface of the uplifted flood-plain, parallel with the main stream, affords an example of a "postponed junction."

being developed from stream to stream, and portions of the ridges or spurs were isolated as a kind of monadnocks.

The Kekerangu Area.

In the lower valleys of the Kekerangu and neighbouring streams flowing to the east coast across a strip of weak mudstone there is also evidence

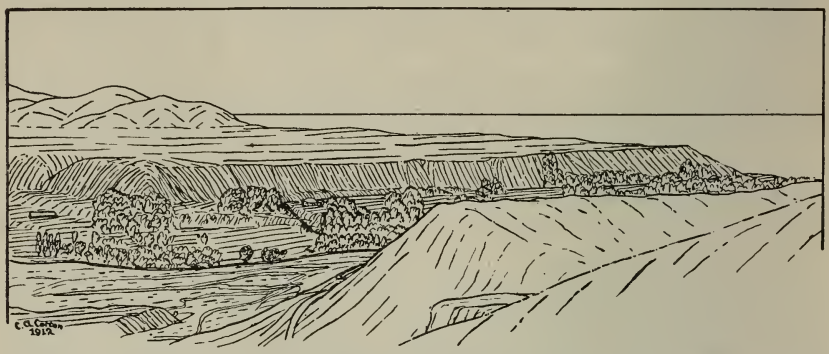

Fig. 4.—The Uplifted Flood-plain and Revived Valley at the Mouth of the Kekerangu River.

of revivals of erosion, and in the period of standstill before the latest of these the Kekerangu had excavated a broad lowland. This was quite probably the same standstill in which the broad uplifted flood-plain of the Awatere was developed. The uplifted Kekerangu flood-plain (see fig. 4) slopes gently seaward, ending in a line of wave-cut cliffs nearly 150 ft. in height, and must have reached a somewhat lower level at the former shore-line. There are, however, reasons for believing that the coast has not been retrograded far, and probably the amount of the uplift is not very far short of 150 ft.; it may be stated at about 120 ft.

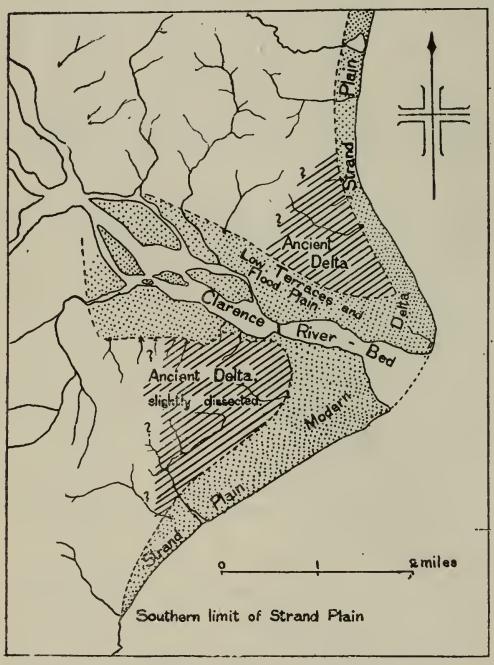

Fig. 5.—Map of the Clarence Delta.

The pause preceding the 120 ft. uplift was sufficiently long to allow one of the neighbouring streams (Deadman's Creek) to erode a mature valley through a ridge of resistant conglomerate (Great Marlborough conglomerate), which it crosses near its mouth, whereas the period that has since elapsed is so short that the gorge cut by the revived stream is still very young, and its grade is interrupted by a fall.

The higher terrace remnants in the vicinity of Kekerangu do not preserve a good record of the earlier movements, but more information is to be obtained from the uplifted Clarence delta, a little farther south.

2. THE UPLIFTED CLARENCE DELTA.

The convex curve of the shore-line at the mouth of the Clarence suggests that the river is building a delta, and this is found to be the case, although only a small proportion of the projection is a delta built with respect to present sea-level. The remainder is a promontory of high land, an uplifted delta, through which the river makes its way to debouch at the point (see figs. 5, 6, and 7).

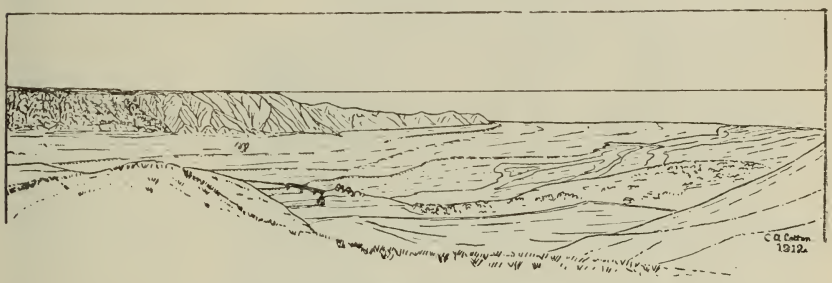

FIG. 6.—VIEW OF THE UPLIFTED AND MODERN DELTAS, LOW TERRACES, AND FLOOD-PLAIN OF THE CLARENCE RIVER FROM A POINT ON THE SURFACE OF THE UPLIFTED DELTA ON THE SOUTH SIDE.

The promonotory so formed is flat-topped, the surface sloping gently seaward, and reaches a height of 580 ft. about half a mile within the present cliffed margin, to which the subaerial top-set beds extend.

It is impossible to say with certainty how far seaward from the present margin of the platform the strand lay at the close of the period during

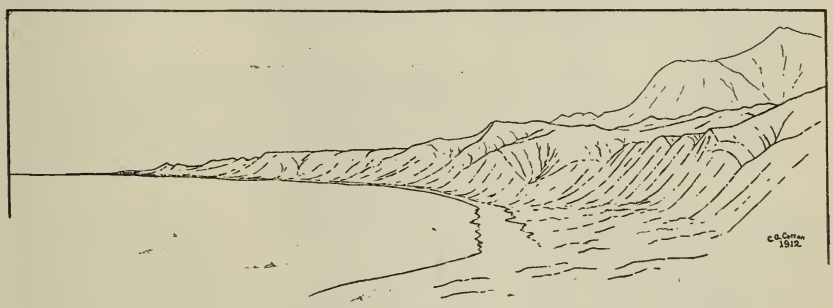

FIG. 7.—VIEW OF THE CLARENCE DELTA FROM THE NORTH.

which the delta was built. The amount of uplift indicated may be taken as 500 ft., which is about the height of the base of the top-set beds.

The least dissected portion of the surface of the ancient delta lies close to the north bank of the Clarence. The even edge of this portion appears in fig. 6. It has escaped dissection because it slopes away from the river.

The writer crossed the southern portion, and found that its dissection shows at least three distinct stages. A broadly rolling, mature, upland surface points to a very long period of rest following an early movement of uplift of small amount, though, on the other hand, this dissection might

have resulted from coast-retrogradation normally taking place towards the end of the stage of maturity in the "delta cycle with stationary crust,"* a period that might possibly be correlated with that at which a valley lowland was developed in the Middle Clarence Valley.† Deep, dissecting valleys, with broad terraces, some of them at a height of 300 ft., are the work of erosion during the later discontinuous uplift, and here, as elsewhere on this coast, the latest rejuvenation has been a very short period in progress.

The fore-set portion of the delta, which, however, does not show stratification, may be examined in the banks of the river near the Clarence Bridge. It consists of gravel of fairly even texture, few pebbles being over 4 in. or 5 in. in diameter, but there is a considerable admixture of finer gravel and sand, and some patches of sand. The material is fairly well cemented. The fore-set portion is distinctly marked off from the top-set (or at least from the subaerial top-set) beds by its bluish-grey colour, corresponding to a low state of oxidation of the finer material, the latter beds being oxidized and of a yellow to reddish-yellow colour. The top-set beds begin with a boulder-bed, possibly of subaqueous or beach origin, which is followed by gravel and clay strata, and their average thickness on the delta proper is about 80 ft. There are very thick accumulations of oxidized fluviatile beds on some lower terraces, which may possibly indicate downward oscillations interrupting the general upward movement.

3. The Rock Platform near Flaxbourne.

Well-preserved remnants of a wave-cut platform which indicate uplift of several feet may be seen half a mile north of the mouth of the Flaxbourne River. The rock exposed on the shore is a fine-grained, argillaceous

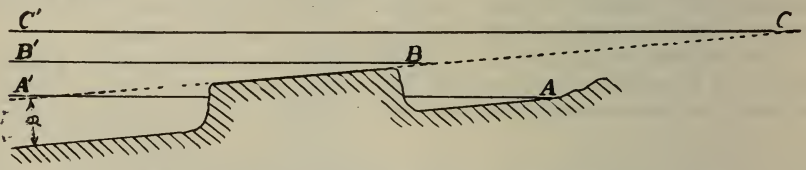

Fig. 8.—Diagram illustrating the Theorem that the Amount of Uplift indicated by Residuals of a Wave-cut Platform is less or greater than the Height of the Residuals above their Base according as the Pre-uplift Position of High-water Mark was Seaward or Shoreward of its Present Position.

sandstone overlying the Amuri limestone. It is in a vertical attitude, but exhibits no bedding, and is but little jointed. Marine denudation planes it off to a surface which slopes gently seaward, and which from a distance appears absolutely smooth, though closer inspection reveals numerous inequalities with a relief of a few inches (see Plate XI), and the tabular remnants of the slightly higher platform, several of which are shown in the photograph, have an exactly similar surface and seaward slope.

Their surface is several feet above the present level of high tide, and they therefore indicate uplift. The height of the residuals above their bases is 6 ft., but this cannot be taken as an absolute measure of the amount of uplift unless it is assumed that the position of high-water mark (in plan) was the same immediately before the uplift as it is now.

* J. Barrell, Bull. Geol. Soc. Am., vol. 23 (1912), p. 396.

† C. A. Cotton, "The Physiography of the Middle Clarence Valley," Geogr. Journ., vol. 42 (1913), p. 228.

Remnants of a Wave-cut Rock Platform Half a Mile North of the Flaxbourne River.

C. A. Cotton, photo.]

In fig. 8, A is the present position of high-water mark, and AA′ is present high-water level. If the former position of high-water mark was seaward of its present position, as at B, the amount of uplift that has taken place (A′B′) is less than 6 ft. If, on the other hand, it was shoreward, as at C, the amount of uplift (A′C′) is greater than 6 ft.

In this case it is improbable that the former position of high-water mark was shoreward of its present position, for there is not a well-defined raised beach. It may, however, have been some little distance seaward.

These residuals, therefore, afford proof of uplift of 6 ft., or somewhat less.

4. THE STRAND-PLAIN OF THE MARLBOROUGH COAST.

From Cape Campbell south-westward to and a little beyond the mouth of the Clarence River the shore is bordered by an almost continuous strand-plain, broken only at one or two points where outcrops of resistant rocks project slightly seaward as rocky bluffs. This coastal strip will be referred to as the Marlborough Strand-plain. Geographically it is of great importance, as it affords the only practicable route between northern and southern Marlborough, and is followed for many miles by the surveyed route of the South Island Main Trunk Railway. Its width varies from a few yards to several hundred yards. Sandhills and dunes form its surface at the wider parts, and the material of the beach varies from coarse sand at the north-eastern end to coarse gravel at the mouth of the Clarence. The bulk of the material is, without doubt, supplied by the Clarence, though smaller streams also contribute a share. The waste supplied is swept north-eastward along the coast by a constant along-shore current, and, the supply being very abundant owing to the mountainous and recently uplifted character of the land, it is not surprising that progradation of the coast has taken place; but it is more difficult to account for the fact that progradation has begun very recently. Proof that this is the case is to be seen in the presence of a line of perfectly fresh-looking wave-cut cliffs at the rear of the strand-plain, and it is clear that the sea reached the base of the cliffs very recently.

Some radical change in conditions must have taken place to bring about this sudden change from retrogradation to progradation throughout the length of forty miles of coast. Two possibilities suggest themselves—(1) increase in the supply of waste, and (2) uplift.

(1.) Increase in the supply of waste without uplift of the coast is regarded as a sufficient cause in the case of a strand-plain at Ancona, in Italy.* In that case the increase is accounted for by rejuvenation following a differential uplift inland. In the case of the Marlborough coast, however, while, as already stated, dissection is now in a very young stage as a result of the recent general uplift, the writer has seen no evidence of more recent differential uplift or warping of the surface that might bring about the change.† Further, the change has taken place so late in Quaternary time that it is difficult to believe that a climatic change of

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* W. M. Davis, Geogr. Journ., vol. 34 (1909), p. 303.

† At only one place in Marlborough was an indication noted of strong tilting or warping of the surface. This was in the case of the small streams flowing north-westward into Lake Grassmere, the uplifted mature floors of which slope down-stream more steeply than the grade of the revived streams. This tilt is probably in sympathy with, or forms one boundary of, a kind of cauldron subsidence, forming a bay, which has later been cut off from the sea by a bar, and has become Lake Grassmere.

sufficient magnitude to bring about sudden marked increase in the supply of waste can have taken place.*

(2.) Since there is other evidence that uplift of small amount has very recently taken place, it is worth while considering its efficiency as a cause of progradation. Rapid uplift, even of small amount, seems to be capable of producing the result if the profile of the neighbouring sea-floor was graded before the movement took place. Slight shallowing of the sea would disturb the equilibrium, subjecting the off-shore deposits to a somewhat stronger wave-action than formerly, and therefore causing them to be reworked and the finer material to go into suspension. Meanwhile the Clarence and the other smaller rivers would continue to pour out their enormous load of waste, the bulk of which would be slightly increased by rejuvenation following the small uplift. The balance previously existing between the supply of waste and the transporting-power of waves and currents having been in this way disturbed, some of the surplus waste would be thrown up along the shore, covering over the rock platforms of the uplifted coast. A similar coastal strip of flat land at the mouth of the Waipara River, in North Canterbury, has also been explained by Speight† as the result of uplift.

It would seem that, in the case of the Marlborough Strand-plain, after the off-shore profile has become graded with respect to the present level of the sea, and waves and currents are again able to dispose of the waste supplied, the attack of the waves on the shore will probably again become energetic, the strand-plain will be cut away, and the cliffs at its rear will again begin to recede. It is, indeed, possible that progradation has taken place many times in the recent past, continuing for a brief period after each small movement of uplift.

Art. XLI.—*Supplementary Notes on Wellington Physiography.*

By C. A. Cotton, Victoria College, Wellington.

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

Fault-line Valleys.

On the map‡ accompanying my former "Notes on Wellington Physiography" the Wellington fault is indicated as ending south-westward in the valley of the Tinakori Stream. This is the end of the fault-scarp, and therefore the end of the line upon which recent movement took place. There is, however, evidence of extensive earlier faulting in the form of a broad zone of crushed rock at the head of the Tinakori Stream and on the divide between it and the Kaiwarra, and farther on there is such an exact alignment of the Upper Kaiwarra and Silver Stream Valleys with the Tinakori Stream and with the Wellington fault-scarp that I am now convinced that all these features constitute a single lineament.

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* R. Speight, however, considers that Canterbury streams indicate that "a maximum of erosion [due to a climatic cause] is past, and another cycle of deposition has commenced." (Trans. N.Z. Inst., vol. 43 (1911), p. 410.)

† R. Speight, Trans. N.Z. Inst., vol. 44 (1912), pp. 224–25.

‡ Trans. N.Z. Inst., vol. 44 (1912), fig. 2, p. 247.

The head of the broad subsequent strike valley—the Karori–Khandallah or "Long" Valley of the paper referred to above—appears to be at Karori. The branch that is now occupied by the Upper Kaiwarra and the Silver Stream, while also probably subsequent, or perhaps resequent, appears to have been guided by a fault-line. It is remarkably straight, and, where the streams in it have been revived, they develop by erosion a scarp on the north-west side, which continues the line of the Wellington fault-scarp, and closely resembles it. This is apparently an example of a fault-line scarp. It will be seen from the map that this valley makes a decided angle with the longitudinal features, which in the southern part of the Wellington Peninsula are nearly meridional.

It has been shown* that the inbreak along the Wellington fault took place very recently; but, if there is any significance in the fact that the Silver Stream rises close to the southern coast and flows inland, the Silver Stream – Kaiwarra Valley is more ancient. Further, there is no topographic evidence of downthrow to the south-east along the line of the valley; the absence of a scarp is particularly noticeable on the divide between the head of the Kaiwarra and the Silver Stream.

These facts, together with the presence of the zone of faulted and crushed rock beyond the end of the Wellington fault-scarp, seem to indicate that a much earlier fault movement than that which produced the existing scarp had taken place along the same line and its continuation, and that, during the long periods of denudation accelerated by successive uplifts to which the Wellington area has been subjected, topographic evidence of the movement has been obliterated. This may easily have taken place even though the formation of the original fault happened long after the folding of the strata.

The foregoing explanation of the features continuing the line of the Wellington fault appears much more satisfactory than an alternative view that fracturing took place contemporaneously with the inbreak along the shore of Port Nicholson, but along a much longer line, and that for a great part of the length of the line shattering of the rocks took place without resultant differential movement.†

It is easy, on the former hypothesis, to account for the coincidence of the Wellington fault with the older-faulted zone. As the Port Nicholson block sank, the fault forming its north-western boundary followed the old line of weakness.

The descriptions given in my former paper of the captures of the Silver Stream and Kaiwarra are not affected, but the valleys of these streams, while they may still be regarded as subsequent, must be described as fault-line valleys.‡

THE HUTT VALLEY.

A brief note on the Hutt Valley is here offered, because the Hutt River continues the line of the Wellington fault to the north-east, just as the fault-line valleys already described continue it to the south-west. I am

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* *Loc. cit.*, p. 258.

† Compare the explanation of fault-line valleys in central Sweden given by Davis (W. M. Davis, Bull. Am. Geogr. Soc., vol. 45 (1913), p. 519; "Die erklärende Beschreibung der Landformen," Leipzig, 1912, p. 170).

‡ Davis, *loc. cit.*; and also "Nomenclature of Surface Forms on Faulted Structures," Bull. Geol. Soc. Am., vol. 24 (1913), pp. 187–216.

able at present, however, merely to hint at a few points. The physiography of the Hutt Valley is a subject that deserves careful investigation and thorough treatment.

The lower portion of the valley is undoubtedly a part of the Port Nicholson depression, resulting from the inbreak along the Wellington fault, that has been filled by a delta built forward by the Hutt River. This is proved by the continuation of the fault-scarp into the lower valley without break.

There appear to be good reasons for believing that the valley of the Hutt River to its very source is determined by a line of faulting which continues the line of the Wellington fault; but it has yet to be shown how far the valley is a fault valley, and how far a fault-line valley.

The predominant, longitudinal, topographic features, which I regard as guided by the strike of the strata, trend rather more north easterly just north of Wellington than they do in the south of the peninsula; but within the basin of the Hutt they are again nearly meridional, trending about N. 10° E. Everywhere the valley of the Hutt meets these longitudinal features at an acute angle (see fig. 1). The Hutt River, which flows

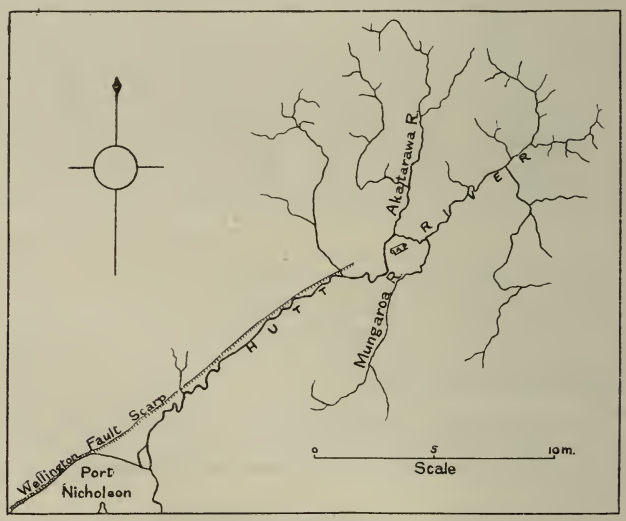

Fig. 1.—Map of the Hutt River System.

S. 60° W., receives tributaries flowing on the one side S. 10° W. and on the other N. 10° E. In the field this is most conspicuous, though the map shows it well only in the case of large tributaries like the Mungaroa and Akatarawa.

Eight miles from the mouth the broad plain of the lower Hutt Valley, which is probably all delta, ends, and the valley, narrowing almost to a gorge, is clearly the work of erosion. Farther up, the valley opens out again, and for five miles has a flat floor, in places a mile in width. The valley here is strongly asymmetrical. The south-east side is formed by long, sprawling, gently tapering spurs, the lower ends of which seem to be buried in an aggraded plain. The spur-ends are not truncated, and thus there is no evidence that the valley has been widened by the river swinging against this side. The north-west side is, on the other hand, formed by

high facets, all in line, which strongly suggest a fault-scarp, but may be a fault-line scarp. It is, of course, true that a vigorous stream, in the process of excavation of a broad-floored mature valley, might itself cut back both its valley-sides to this form, but the absence of bluffs on the south-east side of this portion of the Hutt Valley negatives this explanation.

This portion of the valley may perhaps be a *Graben*, bounded, as the northern end of the Port Nicholson depression is perhaps also bounded, by a fault on one side and a flexure on the remaining sides. Fig. 2 shows two trough subsidences formed in this way along a single fault, and bearing to each other a relation similar to that between the lower and upper plains of the Hutt Valley. The sea may be supposed to have access to the nearer of the two troughs, and to fill it up to the broken line. The broken line in the farther trough represents the level of a lake occupying the trough, and overflowing at the lowest point (the south-west end) along the fault-scarp. If a river were already in existence flowing south-westward along the fault-line, and if the subsidence took place rather slowly, the farther trough might be filled with waste as rapidly as it was formed, a graded

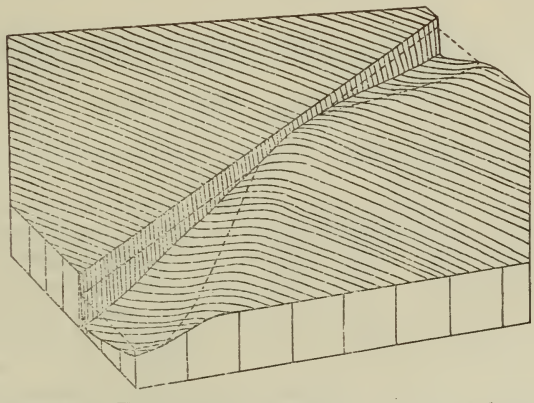

FIG. 2.—DIAGRAM OF TWO TROUGH SUBSIDENCES ALONG A SINGLE FAULT.

gorge being at the same time cut along the fault-line between the two troughs. When later a delta had been built out into the nearer trough the system would bear a good deal of resemblance to the Hutt Valley.

In the actual case the pre-faulting surface was of strong relief, and unless the Hutt River already existed it is difficult, if not impossible, to account for the present large drainage-basin of the river, for the amount of the fault-movement seems insufficient to effect profound changes in drainage.

Thus we have several reasons for believing that before the Wellington fault movement took place the Hutt River existed as a fault-line river guided by the same old fault as the Upper Kaiwarra.

Another indication of the previous existence of the Hutt is found in the presence of a broad terrace along the north-west side of the river near the mouth, evidently a remnant of the flood-plain of the Tongue Point cycle, the front of which is formed by the fault-scarp.

The continuous scarp that bounds the Hutt Valley on the north-west side seems to be—at least, in part—a fault-scarp. If it is true, however, that the recent break occurred along the floor of an older valley, the fault-

scarp can be of no great height, and the higher facets, like those in the Upper Kaiwarra and Silver Stream Valleys, probably form part of a fault-line scarp.

The Old Fault-line.

It is possible that the old line of fracture, the extent of which has been indicated in these notes, represents, in the Wellington area, the Kaikoura orogenic movement,* which was accompanied in Marlborough by the formation of enormous reversed faults. This view gains some support from the fact that the numerous planes of movement of this old distributed fault at the head of the Tinakori Stream dip north-west, whereas the Wellington fault-scarp faces the south-east.

It is not, however, advisable to attempt a correlation with any particular fracture in the South Island.†

Art. XLII.—*Note on the Andesites of White Island.*

By R. Speight, M.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 3rd December, 1913.*]

When Mr. W. R. B. Oliver visited White Island in December, 1912, in order to examine the ecological conditions of its vegetation, he collected specimens of rocks from various points, and kindly handed them over to the Canterbury Museum. The collection includes specimens of sulphur and crystals of gypsum ; but more interesting from the geological standpoint are the volcanic rocks. The only published description of igneous material from this locality is that by W. A. MacLeod, in a paper entitled "Note on a Hypersthene Andesite from White Island."‡ In this he describes a solitary specimen, giving its macroscopic and microscopic characters, and also a chemical analysis of the rock. The collection made by Oliver appears to be fairly complete, and includes variations from MacLeod's rock. I have therefore furnished a few additional notes on the character of the lavas of this interesting island.

It has been pointed out by various authors that the island lies on a broken line of volcanic vents stretching from Ruapehu in a north-easterly direction across the Pacific, and including Mounts Tauhara, Edgecumbe, the Kermadec Islands, and various centres of activity near the Tonga Group. Marshall would terminate the line with this group,§ but if this line be continued it will pass through the Samoan and Sandwich Island volcanic lines at the point of their present maximum intensity. This may be only a coincidence, but, if so, it is a somewhat striking one. It points rather to the intersection of a line of crustal weakness running north-east with two others running north-west by west (see Dana, "Characteristics of

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* C. A. Cotton, Geogr. Journal, vol. 42 (1913), p. 227.
† See, however, A. McKay, Geol. Surv. of N.Z., Reports 1890–91 (1892), p. 19.
‡ Trans. N.Z. Inst., vol. 31, 1899, p. 488.
§ Report Trans. Aust. Assoc. Adv. Sci., 1909, p. 446.

Volcanoes," p. 361). There does not appear to be any general resemblance in the character of the flows from widely separated points of this north-east line, even from those points which are generally accepted as belonging to it. There is a considerable difference between the augite-hypersthene andesites and the augite-hornblende-hypersthene andesites of the Ruapehu group and the augite-olivine andesites and olivine-basalts of the Kermadecs and Tofua in the Tonga group; so that the absence of close resemblance of the Savaiian and Hawaiian lavas can hardly be urged against this hypothesis, even granting that a general similarity of type could be expected from closely connected vents on the same line of weakness—a condition which is very open to question. But there is certainly a very close agreement between the White Island volcanics and those of Ruapehu and Tongariro, as the following notes will show.

In the hand-specimen all the samples are of dark-grey colour, and vary from compact to scoriaceous. Small phenocrysts of feldspar and of the pyroxenes are visible to the eye. The specific gravity varies from 2·60 in the more scoriaceous varieties to 2·66 in the more compact. This corresponds with MacLeod's specific-gravity determination of 2·65.

Two specimens are from sea-level on the south coast. The first (No. 379 of the collection), when examined under the microscope, shows ordinary andesitic characters. Phenocrysts of feldspar, hypersthene, augite, and very occasional olivine are distributed in a groundmass of the pilotaxitic type. The feldspar is a medium labradorite as determined by the statistical method of Michel Lévy, zonal structure being extremely common, and inclusions or signs of alteration rare; hypersthene crystals are extremely numerous, exhibiting straight extinction and moderately low polarization colours; augite occurs in well-defined crystals, frequently showing twinning, and with high extinction-angles. The olivine appears as small crystals, clear, with brilliant polarization colours, and occasionally, where it was possible to obtain it, yielding the characteristic interference figure of a mineral with an axial angle nearly equal to 90°. Magnetite occurs freely as grains. The F.M. minerals are distributed throughout the slide, but occasionally occur in nests composed of only one mineral, or of two, or sometimes of all three minerals together. The groundmass consists of a felted mass of feldspar laths and microlites of either augite or hypersthene; some of these exhibit a greenish shade, and suggest the former mineral.

Another specimen from the south coast, at sea-level, is of the glassy type of groundmass with a few feldspar microlites, and with a much smaller proportion of hypersthene and augite. The feldspars, which are larger in size than the average for the rocks, contain numerous inclusions of the glassy groundmass. This shows numerous well-defined perlitic cracks, and is rendered almost opaque with a dust of some dark-coloured mineral, probably magnetite.

Very similar to this one is a specimen from the base of the cliff on the south side of the crater. Another sample, from the landslip at head of the crater, is like the first rock described (No. 379); but occurrences intermediate between the pure glassy type and the pilotaxitic type come from flows at sea-level in Crater Bay and from the north coast.

A flow from sea-level on the west coast of the island shows a divergence from the usual characters of these andesites. It contains, in addition to the usual plagioclase, a certain amount of sanidine, and the groundmass is composed of untwinned feldspars of rectangular shape and augite grains

without any glass, thus showing a distinct connection with the trachytes. The ferro-magnesian elements consist of the usual hypersthene and augite, some of the latter in fairly large crystals and beautifully twinned.

It will thus be seen that there is a very close resemblance in the rocks of White Island to those of the great volcanoes lying in the middle of the North Island, and to the rocks, recently described by Bartrum,* occurring south of Tauranga, in the Te Puke district, although these last evidently belong to a much earlier period.

Art. XLIII.—*Additions to the List of Fossils from the Lower Waipara.*

By R. Speight, M.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 5th November, 1913.*]

The following list of fossils is based on collections made by the author last January on the banks of the Waipara River, about a quarter of a mile below Greenwood's Bridge, and opposite to the point where Double Corner Station was once situated. The beds consist of sands and sandy clays, with occasional hard concretionary bands which strike north-west and dip south-west at angles in the vicinity of 15°. They represent one of the higher horizons exposed in the gorge, and pass up conformably into the beds exposed near the mouth of the Waipara River, which here consist of clays with occasional layers of coarse shingle, and seams of lignite which have a marked resemblance to the beds exposed on the south-eastern flanks of Mount Grey and form the Mount Grey Downs. No fossils have been found in these beds, but the lithological resemblance is so close that they may be assumed, at any rate tentatively, to be of the same age.

The greater number of the fossils enumerated in my former paper on this locality were from a lower horizon, which is well exposed on the high banks somewhat higher up the river, about a mile above the bridge. My reason for publishing this list is merely to help as far as possible in the elucidation of our Tertiary sequence, for, as matters now stand, the collection of fossils in particular localities, with due regard to zoning, is the most pressing work to be done, and therefore I have ventured to submit this list, although it is a comparatively short one. I am indebted to Mr. Henry Suter for his kindness in aiding materially in the identification of the forms.

Chione meridionalis Sowerby.
—— *stutchburyi* Gray.
Cytherea oblonga Hanley.
—— *enysi* Hutton.
Mesodesma grande Hutton.
Mytilus edulis Linné.
Ostrea angasi Sowerby.
Pecten triphooki Hutton.
—— *hillii* Hutton.
—— *crawfurdi* Hutton.
Tellina deltoidalis Lamarck.†
Ancilla australis Sowerby.
—— *depressa* Sowerby.
—— *pseudaustralis* Tate.
Cerithidea bicarinata Gray.
Fulguraria arabica Martyn.
Polinices ovatus Hutton.
Seila terebelloides Martens.‡
Siphonalia sp.
Turritella symmetrica Hutton.

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* Seventh Annual Report, N.Z. Geol. Survey, Appendix C, 1913, p. 141.
† This species has been noted previously only from the Pleistocene.
‡ This species has been known previously only from the Pliocene.

ART. XLIV.—*Notes on some Recent Earthquakes in New Zealand.*

By G. HOGBEN, M.A., F.G.S.

[*Read before the Wellington Philosophical Society, 24th September, 1913.*]

INNER NEW ZEALAND REGION.

(1.) *16th March, 1912.*—A sharp shock. Epicentrum about sixteen miles north-west of Westport.

(2.) *26th May, 1912.*—Felt at Stratford, New Plymouth, Auckland, Thames, Morrinsville, Tauranga, Wanganui, Wellington. Maximum intensity, observed at New Plymouth, VII–VIII on the Rossi-Forel scale. Several chimneys fell at New Plymouth; one chimney fell at Auckland. Intensity at Hamilton, VI–VII, R.-F. scale. Double origin: (*a*.) 38° 28′ S., 173° 51′ E., forty miles north by west of New Plymouth, about sixteen miles from the origin of earthquake of 24th June, 1891; (*b*) near south west end of Waiheke Island, at the entrance of the Firth of Thames.

(3.) *22nd February, 1913.*—Westport earthquake, VIII–IX, R.-F. scale. Epicentral area, at least twenty miles long, running north-north-east; principal movement from a point about twenty-two miles west-south-west from Westport, opposite Tauranga Bay.

(4.) *16th April, 1913.*—Sharp, IV–V, R.-F. scale. Origin near Lake Manapouri.

(5.) *12th July, 1913.*—Sharp, near origin of earthquake of 24th June, 1891.

It will be noted that these five earthquakes (besides a number of slighter shocks felt at Westport and some proceeding from an origin apparently north-west of Cape Farewell) came from origins lying near a line parallel to the general axis of New Zealand. Moreover, the origin of a very severe earthquake on 7th September, 1910, observed at all the chief stations of the world, was near the Kermadecs on a continuation of the same line. Near the same line, to the south-south-west, in lat. 52° S., 153° E., occurred also another world earthquake on 3rd February, 1910.

OUTER NEW ZEALAND REGION.

(6.) *12th April, 1913.*—Felt all along the east coast, in the Wairarapa, Wellington, and Manawatu districts. Probably proceeded from the well-known region, 200 miles east-south-east of Wellington (between Wellington and the Chatham Islands), which gave us the severe shock of 9th August, 1904. As in that shock also, the level at Wellington was slightly tilted towards the west. This suggests a series of folding movements about axes nearly parallel to the general axis.

FURTHER NOTES ON THE WESTPORT EARTHQUAKE OF 22ND FEBRUARY, 1913.

Times.—Christchurch (Milne seismograph): Preliminary tremors (?), 1.09·1; long waves commence, 1.09·7; maximum, 1.10·1. Riverview Observatory, Sydney (Wiechert horizontal pendulum): P.t., 1.08·2; long waves, 1.12·6 and 1.16·15. Westport: 1.08, or perhaps 1.07·5 (Morgan). Nelson (galvanometer), 1.09. (All times are Greenwich mean civil time.)

It is difficult to determine which times at Sydney and Christchurch belong to the same phases (the instrument at Wellington was not working,

owing to the absence of the observer). The hypothesis that seems to agree most nearly with the times, and with the evidence of stopped clocks and other notes of direction, is that the principal point of maximum disturbance was situated about 155 miles from Christchurch and twenty to twenty-five miles west-south-west from Westport, and that the epicentral area extended north-north-east and south-south-west from this point about fifteen to twenty-five miles in each direction.

Direction (as stated by observers).—Nelson, north-east to south-west; Charleston, west to east; Westport, south-west to north-east; Buller Gorge, south-west.

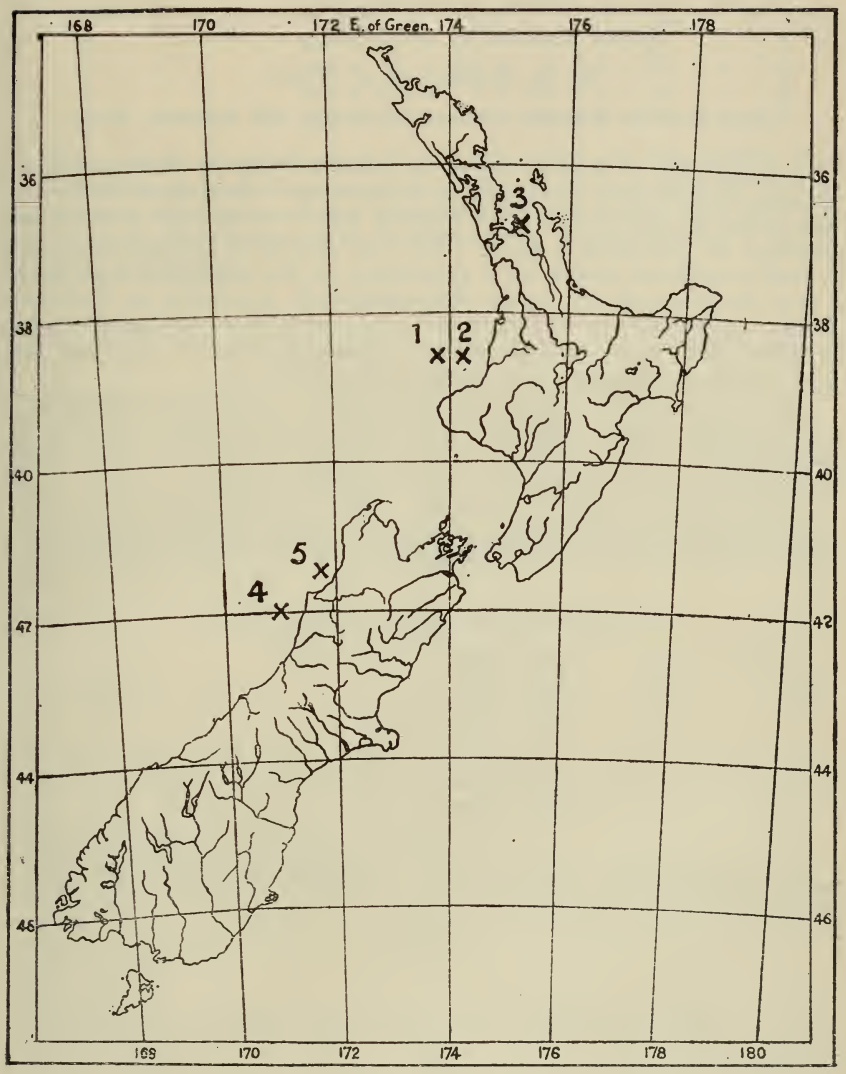
Duration.—Very variously stated, varying from 4 seconds to 1 minute; the best observations, by two engineers who specially timed the shock, give the time of the principal vibrations as 10 to 12 seconds.

Effects.—Westport: Movable objects overturned, crockery and bottles broken generally; plaster fell from ceilings and walls in some buildings; numerous chimneys destroyed or damaged (mostly old chimneys, according to some observers); brick post-office cracked, south-west wing moved ½ in. on its base towards south-west, and metal down-pipe was bent; loose rocks fell from cliffs; cracks were formed in bridge embankment at Orawaiti; slips formed on Buller Road and on railway; narrow fissures opened in made ground; rents and fissures on beach parallel to coast, especially between Cape Foulwind and Tauranga Bay; shock felt with same intensity for about fifteen miles each way along coast from Cape Foulwind (Morgan); walls running east-and-west cracked right through; shop-windows broken in street running north by west to south by east; clocks stopped facing south-west and north-east; tidal wave reported (doubtful, it was a spring tide); preceded by boom, as if of blast or explosion, and accompanied by rumbling. Waimangaroa: Clock facing north-east stopped. Charleston: Doors and windows rattled; lamps and crockery thrown down; rock-falls from hillsides; crack in ground on north beach; rumbling 5 or 6 seconds before, also afterwards. Hokitika: Clocks stopped; rumbling. Greymouth: Clock facing east stopped; bell of town clock chimed, also fire-bell; a few movable objects fell; two chimneys thrown down. Reefton: Movable objects thrown down; bricks dislodged. Murchison: Two clocks stopped, facing north. Lyell: Clock stopped, facing east by north. Mokihinui: Clocks facing east and west stopped. Cape Foulwind: Cliff-fall; all jars fell off shelves; &c.

Previous Shocks.—16th March, 1912 (see above); 12th December, 1912, about 8 p.m., with rumble.

After-shocks.—I have received records of fifty-two (Mr. P. G. Morgan, Director of the Geological Survey, says seventy after-shocks were reported). Those reported to me occurred as follows: 22nd February, 16; 23rd February, 7; 24th February, 7; 25th February, 5; 26th February, 2; 27th February, 2; 2nd March, 2; 5th March, 2; 6th March, 1; 8th March 2; 10th March, 3; 12th March, 1; 15th March, 2. Most of the shocks, according to most observers, were immediately preceded by loud booms. Of twenty-six observations actually taken by Mr. Morgan, twelve were shocks with rumbles, seven shocks without rumbles, and seven rumbles without perceptible shaking.

[Much valuable assistance was given to me in the collection of data by Mr. P. G. Morgan; also by Mr. T. Thompson, County Engineer, Westport, and by many private correspondents.]



× 1. Origin of earthquake of 24th June, 1891.
× 2. } „ „ 26th May, 1912.
× 3. }
× 4. „ „ 22nd February, 1913.
× 5. „ „ 16th March, 1912.

Art. XLV. — *Preferential Voting in Single-member Constituencies, with Special Reference to the Counting of Votes.*

By G. Hogben, M.A., F.G.S.

[*Read before the Wellington Philosophical Society, 24th September, 1913.*]

This subject was so fully discussed in October, 1882, by Professor E. J. Nanson, of Melbourne University, in a paper on "Methods of Election," read before the Royal Society of Victoria, that some apology seems to be necessary for discussing it again. But if an interval of thirty years is not in itself a sufficient reason for a restatement of the arguments then used, I may be pardoned for saying that, absolutely conclusive as Professor Nanson's arguments were, the method of counting the votes proposed by him was so cumbrous as to deter the ordinary politician from giving the case set forth in the paper the attention it deserved.

In this paper I have described a method of counting that appears to me much simpler than Nanson's, although in reality based on the same general principles as his; and I have added the outline of a proof which is, to some extent at all events, independent of his proof.

I shall begin by taking an example. Let us suppose that there are five candidates, of whom one is to be elected, and that there are 400 voting-papers, the votes being distributed as follows :—

Table I.—Order of Preference shown.

A B C D E	on 100	papers.
B A C E D	on 80	,,
D E C A B	on 100	,,
E D C B A	on 60	,,
A C B E D	on 10	,,
C B A D E	on 40	,,
B C A D E	on 10	,,

(I assume, for this example, that these are the only preferences shown out of all the possible permutations.) According to Nanson, the score-sheet would be then exhibited as follows :—

Table II.

——	First Choice.	Second Choice.	Third Choice.	Fourth Choice.	Fifth Choice.
A ..	110	80	50	100	60
B ..	90	140	10	60	100
C ..	40	20	340	0	0
D ..	100	60	0	150	90
E ..	60	100	0	90	150

In order to ascertain which should be rejected, Nanson constructs, after the method of Borda, the trial table below, which is obtained from Table II by multiplying the first choices by 4 (one less than the number of candidates), the second choices by 3, the third by 2, the fourth by 1, and the fifth by 0.

TABLE III *(First Trial Table).*

A	.. ..	440 + 240 + 100 + 100 + 0 = 880 points.	*Trial Totals.*
B	.. ..	360 + 420 + 20 + 60 + 0 = 860 ,,	
C	.. ..	160 + 60 + 680 + 0 + 0 = 900 ,,	
D	.. ..	400 + 180 + 0 + 150 + 0 = 730 ,,	
E	.. ..	240 + 300 + 0 + 90 + 0 = 630 ,,	

Nanson then rejects all those whose trial totals are not greater than 800, the average of all the trial totals. (He shows by a rigid process the soundness of this step.) A new score-sheet similar to II is then made for the remaining candidates, A, B, C, disregarding votes given for D and E. It will be as follows :—

TABLE IV.

——	First Choice.	Second Choice.	Third Choice.
A	110	180	110
B	90	200	110
C	200	20	180

Multiplying the first choices by 2, the second by 1, and the third by 0, we get a trial table similar to Table III, thus :—

TABLE V *(Second Trial Table).*

A	220 + 180 + 0 = 400 points.	*Trial Totals.*
B	180 + 200 + 0 = 380 ,,	
C	400 + 20 + 0 = 420 ,,	

The average of the totals is 400 ; he cuts out A and B, who have totals not greater than the average, and C is accordingly elected. Assuming that the preferences are truly and rightly given, and that each voter exercises all his preferences, this method is infallible.

Nanson proposes to neglect the cases in which no preference is shown for more than a few candidates ; but his method could be made complete by distributing the points that would thus be unassigned in Table III equally among the unmarked candidates. It is generally agreed, however, that Nanson's method, although mathematically sound, is too cumbrous for actual use.

But it can be shown that a trial table constructed as Table VI below gives the same totals as Nanson's Trial Table III above, and that the other trial tables required can be derived directly from it without any fresh count or calculation, except mere addition of figures already obtained.

The Trial Table VI is thus constructed : We make as many lines and as many columns as there are candidates ; we count the number of ballot-papers on which the first candidate on the list is preferred to the second, all other names being disregarded, and papers on which no preference is shown for either of these candidates being divided equally between them. The number so found is inserted in the second line of the first column—that is, total preferences of A over B = 210. (The same count gives us the number for the first line of the second column—that is, the number of papers (190) on which the second candidate is preferred to the first.) Each of the other spaces in the table is similarly filled up.

TABLE VI *(First Trial Table).*

——	A.	B.	C.	D.	E.
Beats A ..	x	190	210	160	160
,, B ..	210	x	210	160	160
,, C ..	190	190	x	160	160
,, D ..	240	240	240	x	150
,, E ..	240	240	240	250	x
Trial totals..	880	860	900	730	630

D and E, *having trial totals not greater than the average, are rejected,* and the columns and lines for D and E are deleted.

The second trial table, which for clearness is here written out again, appears as follows :—

TABLE VII *(Second Trial Table).*

——	A.	B.	C.
Beats A	x	190	210
,, B	210	x	210
,, C	190	190	x
Trial totals ..	400	380	420

A's and B's trial totals being not greater than the average of the trial totals (400), they are rejected, and C is declared elected.

The soundness of this method can be proved independently of Nanson's method ; for the successful candidate is, *generally*, the candidate who would be preferred to any other single candidate if they were the only two candidates : hence if n, which must be either of the form 2N or of the form 2N + 1, be the total number of voting-papers, the successful candidate must as against any other candidate obtain at least N + 1 votes, and his trial total must not be less than $(m - 1)$ (N + 1), where m is the number of candidates. These total preferences occur in pairs, and the sum of each pair is n—*e.g.*, in Table VI the total preferences of A over B is 210, and of B over A 190, and their sum is 400. The number of pairs is $\frac{m(m-1)}{1 \cdot 2}$; therefore the average of all the trial totals is $\frac{1}{2}nm\ (m - 1) \div m = \frac{1}{2}n\ (m - 1)$, which is either of the form $(m - 1)$ N, or of the form $(m - 1)$ $(N + \frac{1}{2})$. Any trial total not greater than this is less than $(m - 1)$ (N + 1). A candidate with a trial total not greater than the average of all the trial totals cannot, therefore, be elected, and may be thrown out at any stage.

I have said that *generally* the successful candidate is the candidate who would be preferred to any other single candidate if they were the only two candidates ; but there are two other cases—namely, the case of equality, and what Nanson calls the inconsistent case. In each of these cases the same rule as that given above applies.

In the case of equality, when at the last stage two or more candidates are equal, and it is necessary to exercise a casting-vote, it is probably the best rule to give this to the candidate of the two or more equal candidates at the last count who stood highest at the first count; or, if this does not determine it, to the one who stood highest at the second count; or, if the candidates in question be equal at all counts, to determine the result by drawing lots.

In the "inconsistent case" there are, say, three candidates—A, B, C—of whom A beats B, B beats C, and C beats A. For instance, if the votes are distributed as in Table I, except that the last two lines are

C B A D E	26
B C A D E	24

then Table VI becomes

TABLE VIII *(First Trial Table).*

—	A.	B.	C.	D.	E.
Beats A ..	x	190	210	160	160
,, B ..	210	x	196	160	160
,, C ..	190	204	x	160	160
,, D ..	240	240	240	x	150
,, E ..	240	240	240	250	x
	880	884	886	730	630

and Table VII becomes

TABLE IX *(Second Trial Table).*

—	A.	B.	C.
Beats A	x	190	210
,, B	210	x	196
,, C	190	204	x
	400	394	406

Following the rule, we reject A and B, and C is elected. Is this result correct?

Now, Table IX shows that the majority that affirms that B is better than C (*i.e.*, 204) is less than the majority that affirms that C is better than A (namely, 210), and less than the majority that affirms that A is better than B (also 210); hence B should go out.

Again, C is better than A; therefore C is elected. (This proof is general in character.) It is evident that the candidate with the biggest net majority will get a greater trial total than the average of the trial totals, and therefore *all those with trial totals not greater than the average must be rejected,* which is the same rule as before. (Cases of equality may occur here also, and should be treated as before.)

It will not be necessary in many cases to fill up the whole of Table VI or Table VIII, which would require $\frac{1}{2}m\ (m - 1)$ entries in the trial table, where m is the number of candidates. (These counts in any case become simpler as the ballot-papers become sorted out in the process of counting.)

From the first preferences shown in Table I the first count would show —A, 110 votes; B, 90; C, 40; D, 100; E, 60. We could count first the papers on which A, the highest candidate in this count, beats C, and the number of papers on which C beats A. We find that C is preferred to A on 210 papers out of 400; A is therefore rejected (provisionally, at least), and his papers are distributed according to the second preferences shown on them. C is then matched against D, whom he beats by 240 to 160; against B, beating him by 210 to 190; and, finally, against E, obtaining 240 as against E's 160. C is therefore elected. Only $m - 1$ counts have been necessary (in this case, 4), and each count is simpler than the one before.

If in the above counting it had been found that B beat C, then it would have been necessary to try B against A to ascertain whether the inconsistent case had occurred; but even then the process of counting might be considerably shortened; and, in general, any candidate whose trial total has been completed may be rejected if that trial total is not greater than $\frac{1}{2}n\ (m - 1)$.

I have purposely chosen an example in which the lowest candidate on the first count is the candidate who should be declared elected, as it shows in a most striking manner the unsoundness of Ware's method, in which the lowest candidate of the first and each succeeding count is rejected. This is the method under the Electoral Act of 1907 in Western Australia. Still more fallacious is the Queensland method under the Act of 1905, where all the candidates except the two highest are rejected at the first count. The second ballot stands in the same category, and, moreover, is open to other objections, especially in that it requires two polls, and gives opportunity for intrigue of various kinds.

The method I have explained gives, I claim, the real choice of the electors, as far as that can be expressed by any system of voting, and it is not too complicated in operation. I venture to claim also that every elector could easily understand the principle involved in the counting: we simply cut out in turn each candidate that is shown to have no chance of election until we have one successful candidate left.

If proportional representation were to be finally adopted, an interim adoption of my method in single-member constituencies would train the electors in the habit of indicating their preferences.

ART. XLVI.—*Methods of Observing to eliminate the Periodic Errors affecting the Readings of the Graduated Circles in Astronomical and Surveying Instruments.*

By W. T. NEILL, New Zealand Survey Department.

[*Read before the Astronomical Branch, Otago Institute, 23rd September, 1913.*]

THE correctness of the divisions on graduated circles is an important consideration when precise measurements are to be made with them.

In ancient times an error of 8′ or 10′ in an astronomical observation was considered negligible, on account of the instruments employed in those days being so imperfect, and therefore incapable of giving more accurate results. At the present time an error of 8″ or 10″ in such observations is enormous, from which we may form an idea of the great improvements effected in the precision of modern instruments.

As an example of the minuteness of the quantity measured, we may compute the fraction of an inch which 1′ of arc represents on a 3 in. theodolite, an angle which this instrument is capable of measuring accurately.

We find the fraction to be nearly the $\frac{1}{2300}$ part of an inch, and to see it as a linear distance the aid of a powerful magnifying-glass is required.

Formerly the circles for angular measurements were divided by hand, and the errors of the graduations were not easily reducible to law.

The invention of the automatic dividing-engine by Ramsden, of London, in 1768 was an event of great importance in the progress of accurate division of the circles intended for angular measurement; but the graduations made by the engine cannot be assumed to be faultless, and an examination of each circle to determine the errors of graduation and those introduced by imperfections in the instrument is one of the most laborious tasks that the astronomer has to perform, and their elimination by special methods of observation is a matter of first importance.

The circles on modern instruments are usually graduated by a dividing-engine, and the errors in the divisions are reducible to some law, which can be discovered by an examination of the circles and an analysis of the results.

The centre of the circle is the centre of the divided rim, but since it turns on an axis which may not be, and commonly is not, coincident with this centre, an error due to eccentricity is introduced.

To make this clear, let C, fig. 1, be the centre of the circle, and O the centre of rotation. Join O C and produce it to X X′. If the circle rotate through an angle XOD, the centre C will describe the small arc C*c*. It is plain that the points of the circle which would, if it were accurately centred, have come under the reading microscopes at A and B will have come to the points *a* and *b*, found by drawing A*a* and B*b* equal and parallel to C*c*, when A and B are two reading microscopes diametrically opposite.

Resolving the small spaces A*a* and B*b* into two, one in the direction of the limb of the circle and the other at right angles to it, the effect of the first resolved part will be that one microscope will read an arc too great and the other an arc too small by the same quantity than they would have read if the circle were centrically placed. The second resolved part will carry the point at A farther from the microscope, and the point at B nearer to the opposite microscope by an equal distance; therefore the mean of the readings will remain unaltered. Hence, by reading two opposite microscopes and taking the mean of the readings the error due to eccentricity is eliminated.

The eccentricity is of more importance in surveying, when the angles of a traverse are obtained by reading one of the verniers, than in astronomical and geodetic observations, when both microscopes are invariably read. Sufficient care is usually taken by the makers in adjusting the centres to

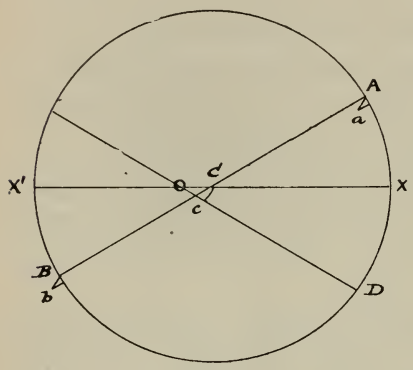


Fig. 1.

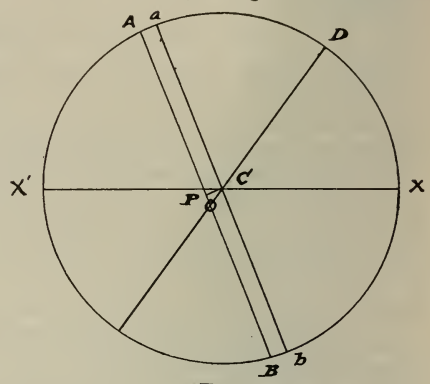


Fig. 2.

reduce the eccentricity to a very small amount. An error of $\frac{1}{1000}$ of an inch in the centring of a 5 in. theodolite will cause a maximum error of 1′ 22″ in the reading of a bearing when it falls on that part of the circle where the effect of the eccentricity is greatest.

To find the eccentricity: In the diagram, fig. 2, let

a denote the microscope or vernier reading.
x = true reading.
θ = XD.
e = eccentricity = OC.

C is the centre of the circle, and O the centre of the alidade.
When the microscope reading is at A or B the true reading is at a or b.
Since e is small, the arc Aa = $a - x$ is sensibly equal to the perpendicular PC from C on AB.

Now PC = $e \sin$ A o D, or $a - x = e \sin (a - \theta)$ .. .. (1)
When $a - \theta = 90°$ or $270°$, $e = \pm (a - x)$,
and for $a - \theta = 0°$ or $180°$, $e = 0$.

Again we have for the opposite microscope

$$b - x = e \sin (180° + a - \theta) = - e \sin (a - \theta).$$

Equating this with (1),

$$2x = a + b.$$
$$x = \tfrac{1}{2} (a + b).$$

The eccentricity is therefore a periodic function which is eliminated by taking the mean of the readings of two opposite microscopes, or more generally by any number of equidistant microscopes. In accordance with this principle, circles are usually equipped with the zeros of the microscopes nearly 180° apart; but as they may not be perfectly adjusted at the distance of 180° we shall put

180° + S = the angular distance of the microscope B from A.

Then if (a) is the division under microscope A, A and B the readings of the two microscopes, the true reading for the microscope A is

$$x = \text{A} + a + e \sin (a - \theta),$$

and for the microscope B

$$180° + \text{S} + x = 180 + \text{B} + a + e \sin (180 + a - \theta),$$

or

$$x = \text{B} - \text{S} + a - e \sin (a - \theta).$$

Equating the two results, and putting $B - A = y$, we obtain the equation of condition

$$y = S + 2e \sin (a - \theta) \quad .. \quad .. \quad .. \quad (2)$$

in which e, S, and θ are unknown.

The value of y can be obtained by any two readings of the microscopes, and if four equidistant readings are taken at the points a_0, $a_0 + 90°$, $a_0 + 180°$, and $a_0 + 270°$, and denoting these values by y_0, y_1, y_2, y_3 respectively, then by putting $E = (a_0 - \theta)$ the following four equations are obtained :—

$$y_0 = s + 2e \sin E = s + 2e \sin E,$$
$$y_1 = s + 2e \sin (E + 90°) = s + 2e \cos E,$$
$$y_2 = s + 2e \sin (E + 180°) = s - 2e \sin E,$$
$$y_3 = s + 2e \sin (E + 270°) = s - 2e \cos E,$$

from which we find

$$s = \tfrac{1}{4} (y_0 + y_1 + y_2 + y_3) \quad .. \quad .. \quad (3)$$
$$\tan E = \frac{y_0 - y_2}{y_1 - y_3} \quad .. \quad .. \quad .. \quad (4)$$
$$e = (y_0 - y_2) \operatorname{cosec} E \quad .. \quad .. \quad (5)$$

In order that the eccentricity may be determined with greater accuracy the circle may be read at a great number of equidistant points. Each pair of readings of the opposite verniers or microscopes furnishes an equation of condition of the form (2), and from all these equations the value of the eccentricity can be deduced by the method of least squares.

In Chauvenet's Astronomy, vol. 2, three theorems, relating to periodic functions, are given to facilitate the solution of the equations. The result leads to a simple rule, which is as follows : Tabulate the values of y as a distance on a bearing of the reading under the microscope, and reduce these on the meridian and perpendicular as in an ordinary traverse. Then we have

$$\tan E = \frac{\Sigma y \sin a}{\Sigma y \cos a} \quad .. \quad .. \quad .. \quad (6)$$
$$n^2 e^2 = X^2 + Y^2 \quad .. \quad .. \quad .. \quad (7)$$

The following values of y B − A were obtained from the horizontal limb of a 5 in. theodolite, by Troughton and Simms, London. The graduations were known, by experience in the field, to be almost perfect. A powerful micrometer microscope was used to obtain the values of B − A from 0° to 360° at intervals of 30°. The readings are in terms of the divisions of the micrometer, and are converted to arc in the second column :—

0°	− 0·014 M.D.	or in arc	− 23″
30°	− 0·018	,, ,,	− 29″
60°	− 0·020	,, ,,	− 33″
90°	− 0·022	,, ,,	− 36″
120°	− 0·020	,, ,,	− 33″
150°	− 0·015	,, ,,	− 25″
180°	− 0·013	,, ,,	− 21″
210°	− 0·010	,, ,,	− 16″
240°	− 0·012	,, ,,	− 20″
270°	− 0·012	,, ,,	− 20″
300°	− 0·009	,, ,,	− 15″
330°	− 0·012	,, ,,	− 20″

Tabulating these values and resolving each into two, one in the direction of the meridian and the other at right angles to it, we obtain the following :—

FORM A.

a.	y.	On Meridian.		On Perpendicular.	
		+	−	+	−
0° ..	−23″	..	23·0	..	..
30° ..	−29″	..	25·1	..	14·5
60° ..	−33″	..	16·5	..	28·6
90° ..	−36″	..	..	..	36·0
120° ..	−33″	16·5	..	..	28·6
150° ..	−25″	21·7	..	..	12·5
180° ..	−21″	21·0	..	..	..
210° ..	−16″	13·9	..	8·0	..
240° ..	−20°	10·0	..	17·3	..
270° ..	−20″	..	..	20·0	..
300° ..	−15″	..	7·5	13·0	..
330° ..	−20″	..	17·3	10·0	..
Sums ..	−291″	83·1	89·4	68·3	120·2
			83·1		68·3
			−6·3		−51·9

$$12e \sin E = -6{\cdot}3 \quad -\log = 0{\cdot}79934$$
$$12e \cos E = -51{\cdot}9 \quad -\log = 1{\cdot}71517$$
$$E = 186° \, 55' \qquad +\log \tan E \; 9{\cdot}08417$$
$$e = +4''{\cdot}3 \qquad +\log 12e = 1{\cdot}71864$$
$$s = \tfrac{1}{12}(-291) = -24''$$

A single reading of the vernier A requires a correction for eccentricity of

$$+4''{\cdot}3 \sin (a - 186° \, 55')$$

The distance between the verniers is $180° - 24'' = 179° \, 59' \, 36''$.

Having found the error in the readings due to eccentricity and the constant angle between the two verniers, we may correct the observed readings for these errors, and the residuals will be the errors due to the graduation of the circle and accidental errors of reading.

A circle may be graduated by copying a certain number of the main divisions directly from the dividing-machine, and then the smaller divisions between these points are performed automatically by setting the machine in motion.

If the circle is not truly centred with the dividing-engine there will be an error in the main divisions due to the eccentricity and an error in the divisions of the smaller arcs, with a shorter period, depending on the number of main division directly copied from the dividing-engine.

These may be investigated in the same manner as for the centres of the circle and the alidade not coinciding, or they may be determined by the method of harmonic analysis as follows by putting

$$y = A_0 + A_1 \cos a + A_2 \cos 2a + \&c.$$
$$+ B_1 \sin a + B_2 \sin 2a + \&c. \quad .. \quad .. \quad (8)$$

Before proceeding with the analysis we have to consider the two systems of measuring angles.

Graduated circles are usually numbered from 0° to 360°, the numbers increasing in the clockwise direction, and azimuths or bearings are referred to the north point as zero. The four cardinal points correspond to

North, 0°	South, 180°
East, 90°	West, 270°

This may be termed the practical method of angular measurement.

In trigonometry the angles are referred to the east point as zero and increase counter-clockwise. The four cardinal points are represented by

North, 90°	South, 270°
East, 0°	West, 180°

If we call this the theoretical method of measuring angles, and if we bring the two zero points to coincide, an angle is converted from one system to the other in this instance by

$$a, \text{ theoretical} = 360° - a, \text{ practical.}$$

Applying this conversion formula to the value of E = 186° 55′, we obtain E (as an azimuth) = 360° − 186° 55′ = 173° 05′, and the line of no eccentricity intersects the graduated circle at the points 173° 05′ and 353° 05′. Hence the reading of the vernier A requires a correction of

$$+ 4''\cdot3 \sin (a - 173° 05')$$

Taking the observed values of B − A and applying the correction for the angular distance between the two verniers, we obtain the errors due to eccentricity and imperfect graduation. Then computing the amount of eccentricity, the residuals represent the errors due to imperfect graduation and accidental errors of reading.

The following form is a convenient method of tabulating these results :—

FORM B.

(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)
a.	B − A	(2) + 24″·25	8″·6 × sin (a − 173°).	− 3″·0 × sin (2a − 76°).	Computed B − A.	Errors of Graduation and Reading.	a.
°	″	″	″	″	″	″	°
9	− 23	+ 1·25	− 1·05	+ 2·91	− 22·4	− 0·6	0
30	− 29	− 4·75	− 5·18	+ 0·83	− 28·6	− 0·4	30
60	− 33	− 8·75	− 7·92	− 2·08	− 34·2	+ 1·2	60
90	− 36	− 11·75	− 8·54	− 2·91	− 35·7	− 0·3	90
120	− 33	− 8·75	− 6·87	− 0·83	− 32·0	− 1·0	120
150	− 25	− 0·75	− 3·36	+ 2·08	− 25·5	+ 0·5	150
180	− 21	+ 3·25	+ 1·05	+ 2·91	− 20·3	− 0·7	180
210	− 16	+ 8·25	+ 5·18	+ 0·83	− 18·2	+ 2·2	210
240	− 20	+ 4·25	+ 7·92	− 2·08	− 18·3	− 1·7	240
270	− 20	+ 4·25	+ 8·54	− 2·91	− 18·6	− 1·4	270
300	− 15	+ 9·25	+ 6·87	− 0·83	− 19·2	+ 4·2	300
330	− 20	+ 4·25	+ 3·36	+ 2·08	− 18·8	− 1·2	330

As a check on the results in column (4) the values of B − A can be analysed by the formula (8)—

$$y = A_0 + A_1 \cos a + A_2 \cos 2a + \&c.$$
$$+ B_1 \sin a + B_2 \sin 2a + \&c.$$

It will generally suffice to compute the first and second coefficients A_1 and A_2, B_1 and B_2, which can readily be done by the method shown on form A.

A scheme proposed by Professor Runge ("Zeitschrift für Mathematik und Physic") is given in Gibson's "Calculus," in which all the coefficients are easily computed.

The following is Runge's scheme slightly altered :—

Harmonic Analysis of Column (2).

0.	1.	2.	3.	——		
− 2·0 − 44·0	− 8·0 − 90·0	+ 5·0 − 101·0	.. − 56·0	C′ diff. C sum.		
− 21·0 − 23·0	− 41·0 − 49·0	− 53·0 − 48·0	.. − 56·0	− 53·0	− 41·0	− 2 0
− 23·0 ..	− 29·0 − 20·0	− 33·0 − 15·0	− 36·0 − 20·0	− 33·0 − 20·0	− 25·0 − 16·0	− 21·0
.. ..	− 9·0 − 9·0	− 18·0 − 13·0	− 16·0 ..	− 13·0	− 9·0	
.. ..	− 18·0 0·0	− 31·0 − 5·0	− 16·0 ..	*d* sum. *d′* diff.		
..	1	2	3			

Cosine Terms.								Sine Terms.					
0 and 6.		1 and 5.		2 and 4.		3.		1 and 5.		2 and 4.		3.	
− 44·0 + 101·0	− 90·0 − 56·0	− 2·0 − 2·5	− 6·9 ..	− 44·0 + 50·5	− 45·0 + 56·0	− 2·0 − 5·0		− 9·0 − 16·0	− 26·9 ..	0·0 ..	− 4·3 ..	− 18·0 + 16·0	
− 145·0 − 146·0		+ 0·5 − 6·9		+ 6·5 + 11·0		− 7·0 ..		− 25·0 − 26·9		0·0 + 4·3		− 2·0 ..	
− 291·0 + 1·0		− 6·4 + 7·4		+ 17·5 − 4·5		.. ..		− 51·9 + 1·9		− 4·3 + 4·3		.. ..	
$A_0 = -24{\cdot}25$ $A_6 = +0{\cdot}08$		$A_1 = -1{\cdot}07$ $A_5 = +1{\cdot}23$		$A_2 = 2{\cdot}91$ $A_4 = -0{\cdot}75$		A_3 $-1{\cdot}17$		$B_1 = -8{\cdot}65$ $B_5 = +0{\cdot}31$		$B_2 = -0{\cdot}71$ $B_4 = +0{\cdot}71$		B_3 $-0{\cdot}33$	

Denoting by y_1, y_2, &c., the first, second, &c., harmonics, the equation to the curve is

$$y = -24''{\cdot}25 + y_1 + y_2 + \&c.$$

or $y + 24''{\cdot}25 = y_1 + y_2 + \&c.$, by changing the origin.

Now $y_1 = -1''{\cdot}07 \cos a - 8''{\cdot}65 \sin a$.

The value of (a) when y_1 vanishes is E, therefore

$$-1''{\cdot}07 \cos E - 8''{\cdot}65 \sin E = 0.$$

$$\tan E = -\frac{1{\cdot}07}{8{\cdot}65}$$

$$E = 172^\circ\ 57'.$$

To find the amplitude e we have

$$2e = -1''\cdot07 \cos 262° 57' - 8''\cdot65 \sin 262° 57' = +8''\cdot61$$
$$e = +4''\cdot3.$$

The period of the first harmonic is 180°.

Again $y_2 = 2''\cdot91 \cos 2a - 0''\cdot71 \sin 2a$.

When the function vanishes; $2a$ becomes E′;

$$\therefore \quad \tan E' = \frac{2\cdot91}{0\cdot71}$$
$$E' = 76° 17'$$

and $2e' = 2''\cdot91 \cos 166° 17' - 0''\cdot71 \sin 166° 17' = -3''\cdot00$

$$e' = -1''\cdot50.$$

The period of the second harmonic is 90°. The coefficients of the third and higher harmonics are so small that they may be dismissed as due to accidental errors of reading.

The observed value of B − A is therefore represented by

$$B - A = -24''\cdot25 + 8''\cdot61 \sin (a - 173°) - 3''\cdot00 \sin (2a - 76°) \quad .. (9).$$

The first term is the difference of the angular distance between the verniers and 180°.

The second term, $8''\cdot61 \sin (a - 173°)$, is, properly speaking, the resultant of any errors of centring, due to two principal causes: First, any error in centring the circle with the dividing-engine when the main divisions were engraved; second, any error in centring the circle with the axis of the alidade.

Any one of these causes, or a combination of them, provided they do not cancel each other, will be eliminated by reading two opposite verniers and taking the mean of the readings.

The third term seems to be too large to be dismissed as due to accidental errors of reading.

Since the period of the harmonic is 90°, we may be justified in assuming that four main divisions of the circle 90° apart were directly copied from the dividing-engine and the smaller divisions on each quadrant performed automatically.

On this assumption we see that errors due to the third term are eliminated by verniers placed 90° apart and the mean of their readings taken.

From these results we can deduce a method of shifting the verniers around the circle when a number of readings are taken to obtain a mean result.

Four readings taken 90° apart will eliminate all the periodic errors. The programme is :—

First	round—	Set vernier A on a.
Second	,,	Set vernier A on $a + 90°$.
Third	,,	Set vernier A on $a + 90° + 45°$.
Fourth	,,	Set vernier A on $a + 135° + 90°$.

In the event of a greater number of readings being taken, the third term is eliminated by any multiple of four, so that eight settings 45° apart should be made.

The vernier A is shifted 45° for the first four settings, then $22\frac{1}{2}°$ for the fifth, and 45° for the remaining settings.

This method is frequently used on triangulation surveys in the Dominion.

The equation (9) may be tabulated and a comparison made with the observed values from which the mean error of a reading of two opposite verniers can be obtained.

In form B the fourth column contains the values of $+ 8''\cdot6 \sin (a - 173°)$. The fifth column contains the values of $- 3''\cdot0 \sin (2a - 76°)$.

The sixth column is the computed values of

$$B - A = - 24''\cdot25 + 8''\cdot6 \sin (a - 173°) - 3''\cdot0 \sin (2a - 76°).$$

Subtracting these from the observed values of B − A in column (2) we obtain the residuals in column (7), which represent the accidental errors of graduation and reading.

These results show that the circle is exceedingly well graduated.

The accidental errors of graduation are not reducible to any regular law. They may occur at any division of the circle with either positive or negative signs with equal probability. They may be found directly by testing the divisions with a micrometer microscope. On an instrument equipped with verniers, the angle between any two divisions of the vernier may be used for this purpose. Such errors may be reduced by a greater number of reading microscopes or verniers, but they cannot be wholly eliminated by any special method of observation.

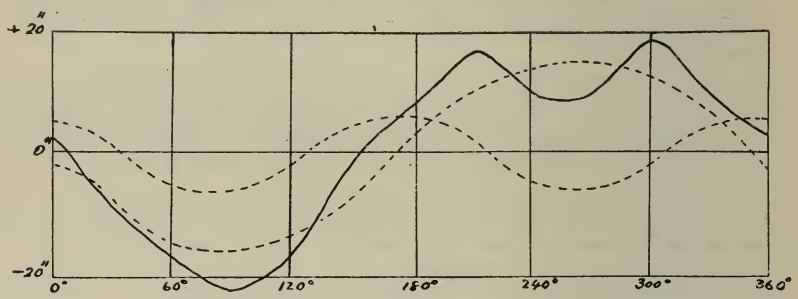


Fig. 3.

A graphical representation of the results is shown in fig. 3.

The firm curve shows the values of B—A as ordinate, for corresponding values of x, 0°, 30°, &c.

The two dotted curves are the first and second harmonics.

Art. XLVII. — *Harmonic Tidal Constants of New Zealand Ports—Dunedin and Port Chalmers.*

By C. E. Adams, M.Sc., F.R.A.S., Government Astronomer of New Zealand.

[*Read before the Wellington Philosophical Society, 22nd October, 1913.*]

As in the case of Wellington and Auckland,* the harmonic tidal constants for Dunedin have been obtained from an harmonic analysis of the hourly ordinates from the automatic tide-gauge records at Dunedin. The tidal abacus of Sir G. H. Darwin was used, and the whole of the calculations have been carried out in duplicate, and with independent checks

* Trans. N.Z. Inst., vol. 45, 1912, p. 20.

where necessary. The constants resulting from this analysis are given in column (1), while those for Port Chalmers, which is eight miles lower down the harbour, are given in column (2).

The constants for Dunedin have been checked by computing from them the heights of the tide on different days, and comparing the values with the gauge-records. The results have shown that the constants have been determined correctly.

And in order to show the characteristic features of the New Zealand tides a comparative schedule is given — (I) comparing the various component tides with the chief lunar tide $M_2 = 1$, and (II) comparing the diurnal tides with the K_1 tide = 1; and for comparison with Australia the component tides for Adelaide, Melbourne, and Sydney are also shown.

In New Zealand the N_2 tide ranks next the M_2 in amplitude, with the S_2 tide third both at Dunedin and Auckland; while at Wellington the S_2 tide is sixth, being smaller than the long-period tides MSf and Mm, and the short-period tides M_2, N_2, and ν_2.

Tide.	(1.) Dunedin, N.Z. (Lat. 46° 7′ S., Long. 170° 30′ E.)		(2.) Port Chalmers, N.Z. (Lat. 45° 55′ S., Long. 170° 32′ E.)	
	H. in English Feet.	κ in Degrees.	H. in English Feet.	κ in Degrees.
S_1 ..	0·016	294	0·074	90
S_2 ..	0·251	125	0·239	107
S_4 ..	0·006	318	0·007	335
S_6 ..	0·005	61	0·003	334
M_1 ..	0·004	178	0·009	165
M_2 ..	2·535	121	2·358	104
M_3 ..	0·019	277	0·018	142
M_4 ..	0·255	174	0·036	316
M_6 ..	0·082	356	0·047	340
O ..	0·088	302	0·087	54
K_1 ..	0·062	90	0·089	79
K_2 ..	0·086	130	..	..
P ..	0·030	34	..	..
J ..	0·004	129	0·005	163
Q ..	0·029	280	0·034	69
L ..	0·116	103	0·116	67
N ..	0·540	105	0·535	84
ν ..	0·043	167	0·175	50
μ ..	0·017	329	0·047	64
R ..	0·008	160	0·024	63
T ..	0·027	67	0·016	302
MS ..	0·113	141	0·075	92
2SM ..	0·026	358	0·060	69
Mm ..	0·072	40	0·100	32
Mf ..	0·073	181	0·142	228
MSf ..	0·106	105	0·081	31
Sa ..	0·099	213	0·123	341
Ssa ..	0·046	77	0·157	117

(1.) New Zealand Tidal Survey: Report of Department of Lands and Survey, Wellington, for 1913–14.—Hourly ordinates for one year beginning 1911, July 1.

(2.) Thomas Wright, Proc. Roy. Soc., London, A. Vol. 83, p. 127: Harmonic Tidal Constants for certain Chinese and New Zealand Ports.—Hourly ordinates for the year 1901.

Port.	New Zealand.						Australia.					
	Dunedin.		Wellington.		Auckland.		Adelaide.		Melbourne.		Sydney.	
Longitude from Greenwich	170° 30′ E.		174° 46′ E.		174° 49′ E.		138° 35′ E.		144° 59′ E.		151° 13′ E.	
Latitude	46° 7′ S.		41° 17′ S.		36° 50′ S.		34° 56′ S.		37° 50′ S.		33° 52′ S.	
Period of observation ..	1 year		1 year		1 year		2 years		1 month		1 year	
Beginning	1911, July 1		1909, Jan. 1		1908, Dec. 1		1889, Feb. 28 1893, Jan. 1		1894, May 1		1888, Jan. 1	
Observations used ..	Hourly ordinates		Hourly ordinates		Hourly ordinates		Hourly ordinates		High & low waters		High & low waters	
M_2 tide in feet	2·535		1·594		3·814		1·700		0·806		1·636	
Tide.	H.	κ.	H.	κ.	H.	κ.	H.	κ.	H.	κ.	H.	κ.
I. Component Tides compared with $M_2 = 1$.												
M_2	1·00	121°	1·00	134°	1·00	204°	1·00	120°	1·00	69°	1·00	254°
S_2	0·10	125°	0·07	333°	0·15	264°	0·99	181°	0·13	164°	0·23	268°
N_2	0·21	105°	0·27	95°	0·21	174°	0·05	246°	0·12	65°	0·20	250°
L_2	0·05	103°	0·06	142°	0·06	210°	0·07	140°	0·02	74°	0·04	237°
ν_2	0·02	167°	0·08	107°	0·06	153°	0·04	76°	0·02	66°	..	..
K_2	0·03	130°	0·03	312°	0·04	255°	0·27	178°	0·03	172°	0·06	268°
K_1	0·02	90°	0·05	78°	0·06	169°	0·49	53°	0·36	132°	0·26	129°
O_1	0·03	302°	0·07	34°	0·02	149°	0·31	32°	0·27	95°	0·21	86°
MS_4	0·04	141°	0·02	138°	0·04	195°	0·05	99°	..	..	..	..
M_4	0·10	174°	0·02	276°	0·03	127°	0·01	173°	0·03	49°	..	..
Mf	0·03	181°	0·03	172°	0·02	205°	0·04	181°	..	..	..	..
MSf	0·04	105°	0·10	61°	0·02	123°	0·07	255°	..	..	..	..
Mm	0·03	40°	0·07	260°	0·03	292°	0·04	200°	..	..	..	..
Ssa	0·02	77°	0·05	166°	0·01	57°	0·13	88°	..	..	0·01	97°
Sa	0·04	213°	0·03	202°	0·02	63°	0·18	126°	..	..	0·06	16°
II. Diurnal Tides compared with $K_1 = 1$.												
K_1	1·00	90°	1·00	78°	1·00	169°	1·00	53°	1·00	132°	1·00	129°
O_1	1·42	302°	1·41	34°	0·25	149°	0·63	32°	0·73	95°	0·80	86°
Q_1	0·47	280°	0·46	26°	0·03	57°	0·08	31°	0·14	77°	..	..
P_1	0·48	34°	0·29	53°	0·29	166°	0·26	57°	0·33	129°	0·33	129°

ART XLVIII.—*On certain Tripolar Relations: Part II.*

By E. G. HOGG, M.A., F.R.A.S., Christ's College, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 4th June, 1913.*]

THE equation $lX + mY + nZ = \kappa$, where $l + m + n \neq o$, represents a system of concentric circles as κ varies. The trilinear co-ordinates $(\alpha_0\beta_0\gamma_0)$ of the centre of the system are

$$\left[\frac{2\triangle l}{a\,\Sigma\,(l)},\ \frac{2\triangle m}{b\,\Sigma\,(l)},\ \frac{2\triangle n}{c\,\Sigma\,(l)}\right],$$

where $\triangle$ is the area of the triangle of reference ABC. Hence the general equation of the system of concentric circles may be written

$$a\alpha_0 X + b\beta_0 Y + c\gamma_0 Z = \kappa.$$

Let $(X_0Y_0Z_0)$ be the tripolar co-ordinates of the centre O, and let ρ be the radius of a circle of the system. Also let this circle meet OA in the point P, and let the angles BPC, CPA, APB be called A′, B′, C′ respectively.

Then $\quad AP = OA - \rho,\ BP^2 = OB^2 + \rho^2 - 2OB\,\rho\cos C'$

and $\quad CP^2 = OC^2 + \rho^2 - 2OC\,\rho\cos B'.$

Hence
$$\begin{aligned}\kappa &= a\alpha_0\,(OA - \rho)^2 + b\beta_0\,(OB^2 + \rho^2 - 2OB\,\rho\cos C') \\ &\quad + C\gamma_0\,(OC^2 + \rho^2 - 2OC\,\rho\cos B') \\ &= a\alpha_0 X_0 + b\beta_0 Y_0 + c\gamma_0 Z_0 + 2\triangle\rho^2 \\ &\quad - 2\rho\,(a\alpha_0\,OA + b\beta_0\,OB\cos C' + c\gamma_0\,OC\cos B').\end{aligned}$$

The coefficient of -2ρ may be written

$$OA\,.\,OB\,.\,OC\,(\sin A' + \sin B'\cos C' + \sin C'\cos B') = O.$$

Hence the equation of the circle is

$$a\alpha_0\,(X - X_0) + b\beta_0\,(Y - Y_0) + c\gamma_0\,(Z - Z_0) = 2\triangle\rho^2 \ldots\ldots\ldots (1)$$

Since $lX + mY + nZ = \kappa$ represents a system of concentric circles, the minimum value of $U \equiv lX + mY + nZ$ occurs for the circle of the system which reduces to a point-circle—*i.e.*, the centre of the system. In this case

$$\begin{aligned}U &= \left\{\frac{2\triangle}{\Sigma\,(l)}\right\}^2\left[\frac{l}{\sin^2 A}\left(\frac{m^2}{b^2} + \frac{n^2}{c_2} + \frac{2mn\cos A}{bc}\right)\right. \\ &\quad \left. + \frac{m}{\sin^2 B}\left(\frac{n^2}{c^2} + \frac{l^2}{a^2} + \frac{2nl\cos B}{ca}\right) + \frac{n}{\sin^2 C}\left(\frac{l^2}{a^2} + \frac{m^2}{b^2} + \frac{2lm\cos C}{ab}\right)\right] \\ &= \left\{\frac{1}{\Sigma\,(l)}\right\}^2\left[lmn\,\Sigma\,(a^2) + a^2mn\,(m + n) + b^2nl\,(n + l) + c^2lm\,(l + m)\right] \\ &= \frac{a^2mn + b^2nl + c^2lm}{\Sigma\,(l)} \\ &= \frac{abc\,(a\beta_0\gamma_0 + b\gamma_0\alpha_0 + c_0\alpha\beta_0)}{2\triangle} = 2RS_0\end{aligned}$$

where $S \equiv a\beta\gamma + b\gamma\alpha + c\alpha\beta$.

Hence the equation of the circle of radius ρ whose circle is at $(\alpha_0\beta_0\gamma_0)$ is

$$a\alpha_0\,X + b\beta_0\,Y + c\gamma_0\,Z = 2RS_0 + 2\triangle\rho^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

If in the above equation [R cos A, R cos B, R cos C] be substituted for $(\alpha_0\beta_0\gamma_0)$ and ρ be made equal to R, we obtain for the equation of the circle ABC

$$a \cos A \; X + b \cos B \; Y + c \cos B \; Z - abc = o \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

If the square of (3) be subtracted from the fundamental relation connecting four coplanar points, viz.,

$$\Sigma (a^2X^2) - 2\Sigma (bc \cos A \; YZ) - 2\, abc \; \Sigma (a \cos A \; X) + a^2b^2c^2 = o, \ldots\ldots (4)$$

we have $$\Sigma (a^4 X^2) - 2\Sigma (b^2c^2YZ) = o,$$

whence

$$(aX^{\frac{1}{2}} + bY^{\frac{1}{2}} + cZ^{\frac{1}{2}}) (- aX^{\frac{1}{2}} + bY^{\frac{1}{2}} + cZ^{\frac{1}{2}}) (aX^{\frac{1}{2}} - bY^{\frac{1}{2}} + cZ^{\frac{1}{2}})$$
$$(aX^{\frac{1}{2}} + bY^{\frac{1}{2}} - cZ^{\frac{1}{2}}) = o,$$

a known relation connecting the distances of any point on a circle from the vertices of an inscribed triangle.

The following list contains the equations of some of the more important circles connected with the triangle.

1. Centre at circumcentre, radius $= \rho$

$$a \cos A \; X + b \cos B \; Y + c \cos C \; Z = 4R \sin A \sin B \sin C \, (R^2 + \rho^2).$$

2. Centre at orthocentre, radius $= \rho$

$$\tan A \; X + \tan B \; Y + \tan C \; Z = \rho^2 \tan A \tan B \tan C + 4\triangle.$$

In-circle of pedal triangle, $\rho = 2R \cos A \cos B \cos C$

$$\tan A \; X + \tan B \; Y + \tan C \; Z = \tfrac{1}{2}R^2 \sin 2A \sin 2B \sin 2C + 4\triangle.$$

Polar circle, $\rho^2 = -4R^2 \cos A \cos B \cos C$

$$\tan A \; X + \tan B \; Y + \tan C \; Z = 2\triangle.$$

3. Centre at centroid, radius $= \rho$

$$X + Y + Z = \tfrac{1}{3}\Sigma (a^2) + 3\rho^2.$$

4. Centre at symmedian point, radius $= \rho$

$$a^2X + b^2Y + c^2Z = \frac{3a^2b^2c^2}{\Sigma (a^2)} + \Sigma (a^2) \rho^2.$$

5. Centre at in-centre, radius $= \rho$

$$aX + bY + cZ = (a + b + c) (2Rr + \rho^2).$$

In-circle, $\rho = r$

$$aX + bY + cZ = (a + b + c) (2Rr + r^2).$$

6. Centre at ex-centre (-111), radius $= \rho$

$$aX - bY - cZ = (b + c - a) (2Rr_1 - \rho^2).$$

Ex-circle, $\rho = r_1$

$$aX - bY - cZ = (b + c - a) (2Rr_1 - r_1^2).$$

7. Circle concentric with circle $I_1 I_2 I_3$, radius $= \rho$

$$a (2R - r_1) X + b (2R - r_2) Y + c (2R - r_3) Z = abcr + 2\triangle\rho^2.$$

Circle $I_1 I_2 I_3$, $\rho = 2R$

$$a (2R - r_1) X + b (2R - r_2) Y + c (2R - r_3) Z = abc (2R + r).$$

8. Centre at Nine-point centre, radius $= \rho$

$$R [a \cos (B - C) X + b \cos (C - A) Y + c \cos (A - B) Z]$$
$$= R^2\triangle (3 + 8 \cos A \cos B \cos C) + 4\triangle\rho^2.$$

Nine-point circle, $\rho = \frac{1}{2}R$

$$a \cos (B - C)\, X + b \cos (C - A)\, Y + c \cos (A - B)\, Z$$
$$= abc\,(1 + 2 \cos A \cos B \cos C).$$

Orthocentric circle, $\rho^2 = \dfrac{R^2}{4}(1 - 8 \cos A \cos B \cos C)$

$$a \cos (B - C)\, X + b \cos (C - A)\, Y + c \cos (A - B)\, Z = abc.$$

9. Circles of Appolonius

$$b^2Y - c^2Z = o, \quad c^2Z - a^2X = o, \quad a^2X - b^2Y = o.$$

10. Circles with centres at Brocard points

$$\Omega\left(\frac{c}{b}, \frac{a}{c}, \frac{b}{a}\right), \quad \Omega'\left(\frac{b}{c}, \frac{c}{a}, \frac{a}{b}\right), \text{ radius} = \rho$$

$$c^2a^2X + a^2b^2Y + b^2c^2Z = a^2b^2c^2 + \Sigma\,(b^2c^2)\,\rho^2$$
$$b^2a^2X + c^2b^2Y + a^2c^2Z = a^2b^2c^2 + \Sigma\,(b^2c^2)\,\rho^2.$$

11. Circle having $\Omega\Omega'$ as diameter

$$a^2\,(b^2 + c^2)\,X + b^2\,(c^2 + a^2)\,Y + c^2\,(a^2 + b^2)\,Z = a^2b^2c^2\,(1 + 2 \cos 2\omega),$$

where ω is the Brocard angle of the triangle.

12. Brocard circle

$$abc\,\Sigma\,(X) + \Sigma\,(a^3 \cos A\, X) = \tfrac{1}{2}abc\,\Sigma\,(a^2).$$

13. Circle on II_1 as diameter

$$-a^2X + (b + c)\,(bY + cZ) = a^2bc.$$

14. Circle on I_2I_3 as diameter

$$a^2X - (b - c)\,(bY - cZ) = a^2bc.$$

15. Circle having the bisector of the angle A as diameter

$$(b + c)\,X + bY + cZ = bc\,(b + c).$$

16. Circle having side of pedal triangle as diameter

$$a^2 \sec A \cos (B - C)\,X + b^2Y + c^2Z = 8\,\Delta^2.$$

17. Circle on BC containing angle λ

$$a \cos \lambda\, X - b \cos (c + \lambda)\, Y - c \cos (B + \lambda)\, Z = abc \cos (A - \lambda).$$

18. Polar circles of the triangles BOC, COA, AOB, where O is the orthocentre of the triangle ABC

$$X = 2bc \cos A. \quad Y = 2ca \cos B, \quad Z = 2ab \cos C.$$

The tripolar equation of the Nine-point circle may be obtained in the following manner.

Let X', Y', Z' be the squares of the distances of any point in the plane of the triangle ABC from the mid-points of the sides of that triangle.

The Nine-point circle being the circumcircle of the medial triangle, its equation is

$$\frac{a}{2} \cos A\; X' + \frac{b}{2} \cos B\; Y' + \frac{c}{2} \cos C\; Z' = \frac{abc}{8}$$

Also $\quad Y + Z = 2X' + \dfrac{a^2}{2}, \quad Z + X = 2Y' + \dfrac{b^2}{2}, \quad$ and $X + Y = 2Z' + \dfrac{c^2}{2}$

Hence $\quad \Sigma\,\{a \cos A\,(Y + Z)\} = \frac{1}{2}\,\{abc + \Sigma\,(a^3 \cos A)\}$

from which we obtain

$$\Sigma\,\{a \cos (B - C)\, X\} = abc\,(1 + 2 \cos A \cos B \cos C)$$

If two circles of radii $R + \rho$ and $R - \rho$ be described concentric with the circumcircle of the triangle ABC, the tripolar equation of the pair of circles is

$$a\sqrt{X - \rho^2} + b\sqrt{Y - \rho^2} + c\sqrt{Z - \rho^2} = o.$$

To prove this, let any point P be taken on the circumcircle: If $\lambda + \mu + \nu = o$, the co-ordinates of P may be taken to be $\frac{2\triangle}{h}\left(\frac{a}{\lambda}, \frac{b}{\mu}, \frac{c}{\nu}\right)$ where $h = \frac{a^2}{\lambda} + \frac{b^2}{\mu} + \frac{c^2}{\nu}$.

The equation of the circle of radius ρ having its centre at P will be

$$\frac{a^2}{\lambda}X + \frac{b^2}{\mu}Y + \frac{c^2}{\nu}Z = \rho^2\left(\frac{a^2}{\lambda} + \frac{b^2}{\mu} + \frac{c^2}{\nu}\right)$$

i.e.,

$$\frac{a^2}{\lambda}(X - \rho^2) + \frac{b^2}{\mu}(Y - \rho^2) + \frac{c^2}{\nu}(Z - \rho^2) = o$$

and the envelope of this circle as λ, μ, ν vary is

$$a\sqrt{X - \rho^2} + b\sqrt{Y - \rho^2} + c\sqrt{Z - \rho^2} = o \qquad (5)$$

and this envelope consists of two circles of radii $R + \rho$ and $R - \rho$ concentric with the circumcircle.

This equation (5) when expanded is

$$\Sigma(a^4X^2) - 2\Sigma(b^2c^2YZ) + 4abc\,\rho^2\,\Sigma(a\cos A\,X) - 16\triangle^2\rho^4 = o.$$

Subtracting this from the fundamental relation (4) multiplied by $4R^2$ we have

$$4R^2\left\{\Sigma(a^2\cos^2 A\,X^2) + 2\Sigma(bc\cos B\cos C\,YZ\right\}$$
$$- abc\,(2R^2 + \rho^2)\,\Sigma(a\cos A\,X) + a^2b^2c^2R^2 + 4\triangle^2\rho^4 = o$$

i.e., $\left\{\Sigma(a\cos A\,X)\right\}^2 - 2\Theta(2R^2 + \rho^2)\,\Sigma(a\cos A\,X) + \Theta^2(4R^4 + \rho^4) = o$

where $\Theta = 4R\sin A\sin B\sin C$;

hence $\left\{\Sigma(a\cos A\,X) - \Theta(2R^2 + \rho^2)\right\}^2 = 4R^2\rho^2\Theta^2$,

or $\Sigma(a\cos A\,X) = \Theta\left[R^2 + (R \pm \rho)^2\right]$,

giving $a\cos A\,X + b\cos B\,Y + c\cos C\,Z$
$= 4R\sin A\sin B\sin C\left[R^2 + (R \pm \rho)^2\right]$,

a result in accord with that previously given.

In a similar manner by supposing the centre of a circle of radius ρ to move on the line $l\alpha + m\beta + n\gamma = o$ we obtain the equation of the pair of straight lines parallel to $l\alpha + m\beta + n\gamma = o$ and distant ρ from it in the form

$$\frac{l^2}{a^2}(F^2 - 4YZ) + \frac{m^2}{b^2}(G^2 - 4ZX) + \frac{n^2}{c^2}(H^2 - 4XY)$$
$$- \frac{2mn}{bc}(GH - FX) - \frac{2nl}{ca}(HF - GY) - \frac{2lm}{ab}(FG - HZ) = o$$

where

$$F \equiv Y + Z - a^2 - 2\rho^2$$
$$G \equiv Z + X - b^2 - 2\rho^2$$
$$H \equiv X + Y - c^2 - 2\rho^2$$

Circles of fixed radius r, whose centres are at the extremities of chords of the circle ABC passing through the symmedian point of that triangle, intersect on a circle whose centre is at the symmedian point, and whose radius is $\sqrt{r^2 - R^2 \tan^2\omega}$, where ω is the Brocard angle of the triangle ABC.

Consider the two points P, Q, whose trilinear ratios are $\left(\frac{a}{\lambda}, \frac{b}{\mu}, \frac{c}{\nu}\right)$ and $\left(\frac{a}{\lambda'}, \frac{b}{\mu'}, \frac{c}{\nu'}\right)$ respectively where $\lambda + \mu + \nu = o$, and $\lambda' = \mu - \nu$, $\mu' = \nu - \lambda$, $\nu' = \lambda - \mu$. The two points satisfy the equation of the circle ABC—viz., $\frac{a}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma} = o$, and the equation of the chord PQ, $\lambda\lambda' \frac{\alpha}{a} + \mu\mu' \frac{\beta}{b} + \nu\nu' \frac{\gamma}{c} = o$ is satisfied by the co-ordinates of the symmedian point (a, b, c).

Hence the tripolar equations of the two circles of radius r whose centres are at P, Q are

$$\frac{a^2}{\lambda}(X - r^2) + \frac{b^2}{\mu}(Y - r^2) + \frac{c^2}{\nu}(Z - r^2) = o$$

$$\frac{a^2}{\lambda'}(X - r^2) + \frac{b^2}{\mu'}(Y - r^2) + \frac{c^2}{\nu}(Z - r^2) = o$$

Hence
$$a^2(X - r^2) : b^2(Y - r^2) : c^2(Z - r^2)$$
$$= \frac{1}{\mu\nu'} - \frac{1}{\mu'\nu} : \frac{1}{\nu\lambda'} - \frac{1}{\nu'\lambda} : \frac{1}{\lambda\mu'} - \frac{1}{\lambda'\mu}$$
$$= \lambda\lambda' : \mu\mu' : \nu\nu'.$$

Therefore
$$a^2(X - r^2) + b^2(Y - r^2) + c^2(Z - r^2) = o$$
or
$$a^2X + b^2Y + c^2Z = r^2\Sigma(a^2),$$
which is the equation of a circle having its centre at the symmedian point of the triangle ABC.

The equation of a circle of radius r' having its centre at the symmedian point is
$$\kappa\,\Sigma\,(a^2X) = \kappa^2\,6Rabc + 2\triangle r'^2,$$
where
$$\kappa\,\Sigma\,(a^2) = 2\triangle$$
Hence
$$\Sigma\,(a^2)\,r^2 = \kappa\,6Rabc + \frac{2\triangle r'^2}{\kappa}$$
$$= \frac{48\triangle^2 R^2}{\Sigma\,(a^2)} + \Sigma\,(a^2)\,r'^2$$

Writing for $\Sigma\,(a^2)$ its value $4\triangle \cot\omega$, where ω is the Brocard angle, we have
$$r^2 - r'^2 = 3R^2 \tan^2\omega$$
i.e.,
$$r' = \sqrt{r^2 - 3R^2 \tan^2\omega}$$

It follows from the above that the length of the minimum chord through the symmedian point is $2\sqrt{3}\,R \tan\omega$.

If H be the circumcentre, O the orthocentre, I the in-centre, and I_1 the ex-centre opposite to the vertex A of the triangle ABC, then (1) if IH = IO either A or B or C is 60°, and (2) if $I_1H = I_1O$ either A is 60° or B or C is 120°

(1.) The tripolar equation of a circle of radius ρ concentric with the in-circle is

$$aX + bY + cZ = (a + b + c)\,(2Rr + \rho^2).$$

If this passes through H, $X = Y = Z = R^2$; hence $2Rr + \rho^2 = R^2$, and the above equation becomes

$$aX + bY + cZ = 2R^2 s.$$

If this circle passes through O, then $X = 4R^2 \cos^2 A$, $Y = 4R^2 \cos^2 B$, $Z = 4R^2 \cos^2 C$, and we obtain

$$a \cos^2 A + b \cos^2 B + c \cos^2 C = \tfrac{1}{2}s$$

$$4a\,(1 - \sin^2 A) + 4b\,(1 - \sin^2 B) + 4c\,(1 - \sin^2 C) = a + b + c$$

i.e., $$\sin 3A + \sin 3B + \sin 3C = o$$

i.e., $$\cos \frac{3A}{2} \cos \frac{3B}{2} \cos \frac{3C}{3} = o$$

whence A or B or C is 60°.

(2.) The tripolar equation of the circle of radius ρ concentric with the ex-circle opposite A is

$$-aX + bY + cZ = (b + c - a)\,(\rho^2 - 2Rr_1),$$

which, if it passes through H, reduces to

$$-aX + bY + cZ = 2\,(s - a)\,R^2.$$

Expressing that this circle passes through O we have

$$-a \cos^2 A + b \cos^2 B + c \cos^2 C = \tfrac{1}{2}\,(s - a)$$

whence $$-\sin 3A + \sin 3B + \sin 3C = o$$

i.e., $$\cos \frac{3A}{2} \sin \frac{3B}{2} \sin \frac{3C}{2} = o,$$

and therefore either A is 60° or B or C is 120°.

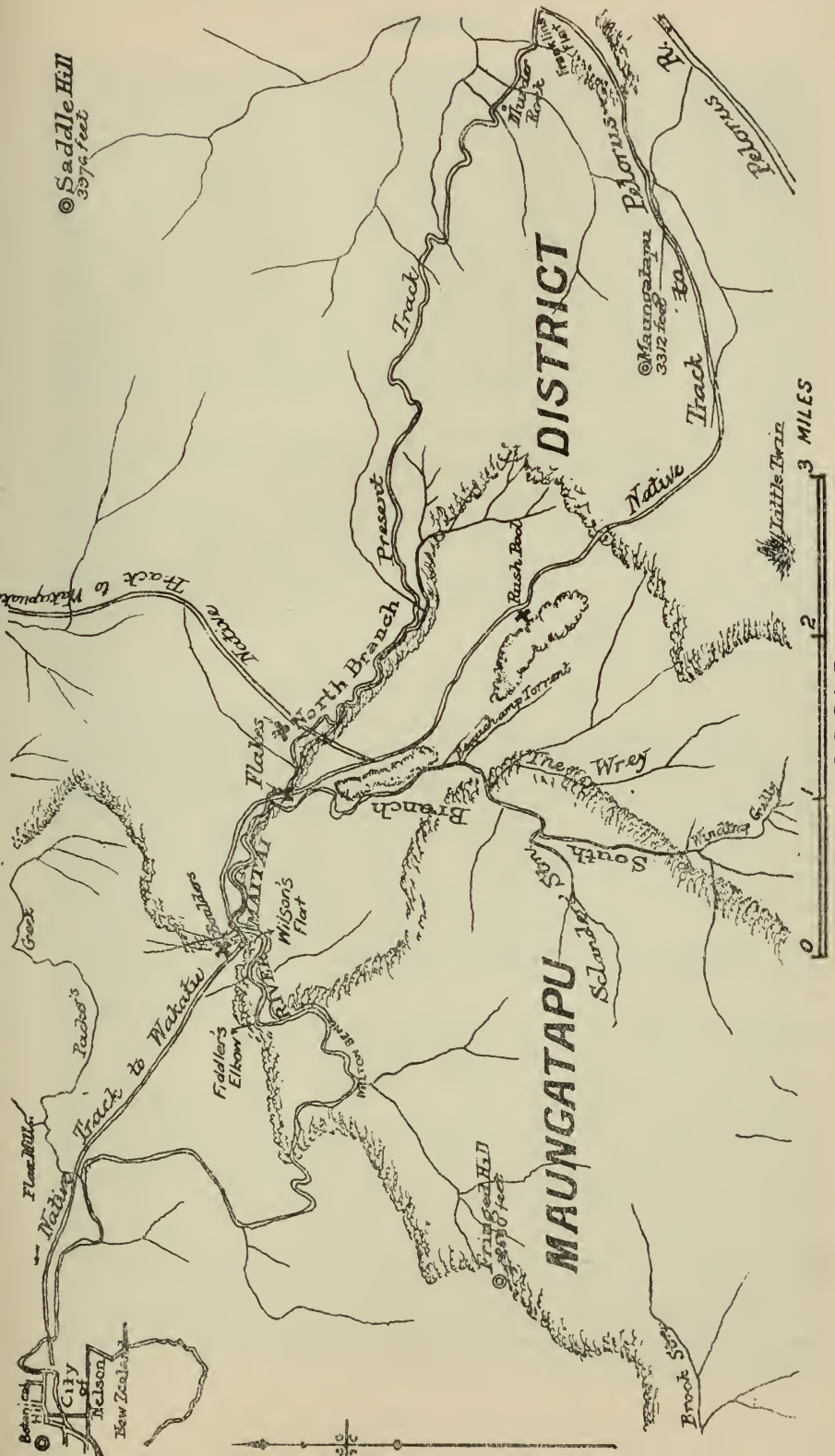
Art. XLIX.—*An Ancient Maori Stone-quarry.*

By H. D. Skinner.

[*Read before the Otago Institute, 17th March, 1910.*]

Plate XII.

About nine miles from the Town of Nelson, on the old Maungatapu Track that leads from the Maitai Forks into the valley of the Pelorus, is a well-known Maori tool-manufactory or quarry. The present road from Nelson follows the Maitai Valley to the Forks, where the old track strikes off up the spur between the north and the south branch. (See map.) On the spur, about a mile from the Forks, the track passes over a small hummock, beyond which there lies a curious hollow in the ridge. This basin encloses a shallow pool of water surrounded by a belt of rushes, from which the place takes its modern name—the Rush Pool. The shores,



LOCALITY MAP.

which, though low, rise steeply from the pool on three sides, are covered with stunted trees, manuka predominating. The north-eastern shore in one part rises barely a foot above the water, and then slopes down into a gully, a continuation of the hollow in which the pool lies. The existence of a pool in so unlikely a place—half-way up the summit-line of a steep spur—is due to a low causeway crossing the bed of a shallow gully. The head of the gully thus cut off forms the basin of the pool. From the north and south rims of the basin the sides of the spur fall steeply away to streams some hundreds of feet below. On the north-west side, behind the observer, the summit-line of the spur falls away, steep, rocky, and bare, to the Forks, about a mile distant. Eastward across the hollow the summit-line of the spur rises steeply to the main ridge, which forms the sky-line, more than a mile away. The spur's northward-facing slope is mineral country, stony and barren, but the southern slope has been invaded by beeches.

The spur is composed mainly of much-disturbed serpentines, and of rocks similar in appearance and composition to those of the Dun Mountain. The surface is covered with masses of these rocks, some of them of great size. For a short distance around the pool masses of argillite lie thickly scattered. This is the stone which the Maoris have quarried for adzes and other tools. When newly fractured it is black in colour, but it weathers rapidly to a light grey. The boulders are of all sizes, and have all, without exception, been tested as to quality either by fire or by the neolithic equivalent of a quartering-hammer.

About the base of every crag or boulder there lies a pile of flakes detached from the parent stone, and left as useless. Around some the earth appears to have been banked up so that the full heat of the fire might play into the surface of the rock. In every direction lie broken pieces that have probably been looked over and rejected. If the spur within a radius of 200 yards of the pool were thoroughly cleared it would probably be found that the whole surface is thickly covered with fractured argillite boulders, spalls, rejects, and flakes. The best stone appears to have been obtained from three special places. The first of these is along the northern slope of the spur, below the pool. The second is the argillite crag on the south-east of the pool, beside the terrace to be referred to later. The third, and probably the chief source, is the argillite cliff that forms the southern face of the hummock over which the track passes before reaching the pool. This part of the spur is covered by beech bush, and so seems to have been examined hardly at all by curio-hunters. In spite of the trees and the thick carpet of leaves that now conceals all minor features, this is the most interesting part of the manufactory at the present time.

When, in the "forties," the late J. W. Barnicoat passed the pool as he was following up the Native track into the Pelorus Valley he saw the ruins of Maori whares.* The spot on which they stood does not appear to have been recorded, but it can hardly have been elsewhere than on the terrace above the pool on its eastern side. The whole of this terrace, part of which is shown in fig. 1, Plate XII, is covered with a layer of flakes so thick that, after the passage of a century, vegetation has grown over it scarcely at all. On the slope from the terrace to the pool the flakes are also strewn thickly; but soil has been washed over them, and they are now overgrown by scrub.

* This information was obtained from Mr. R. J. Kingsley, who had it from Mr. Barnicoat. But no whares are marked on the map compiled from Barnicoat's traverse. One is shown farther up the spur.

The western boundary of the quarrying area is marked by a large group of boulders on the south slope below a point on the track some 500 yards from the pool. The lower parts of these rocks have been fractured by fire, but the quality of the stone is poor, and nothing further has been done. About 200 yards farther on the true area begins, and artificial flakes at once become plentiful. Beside the track is a small boulder which appears to have been superheated by fire. It has been split into white and powdery fragments. The stone-hewers naturally directed their efforts against the lower edges of boulders when attacking them by fire. In many places, notably at the crag by the flaking terrace, the earth appears to have been built up close to the rock-edges, so that the glowing embers might be close to the face of the stone. The use of fire in this way is the only possible explanation of the fractured surfaces in places where there is not room to swing a hammer-stone. Mr. Elsdon Best supplies me with the following note regarding the process: "A very good (Maori) authority tells me that a fierce fire was kept burning on the face of the rock until it became red with heat. Water was then thrown on it. This caused the surface to crack and split up into small, or comparatively small, pieces; but the rock underlying the shattered surface became not shattered, but merely cracked in fairly large pieces. The shattered surface was loosened and thrown away, then the underlying part was split open (*koara*) and suitable pieces selected (uncracked pieces) for *toki*, &c. Surface rock was always deemed inferior, and was not used. Interior stone was much better for tools. The best stone of all was obtained from below the surface of water." It will be noticed that fire is of no avail unless water is applied.

A second method of fracturing the rock is by means of a hammer-stone. This would be effective in the case of small-sized boulders. In the case of large masses of rock little could be done by hammers except surface-flaking, unless the rock had been opened up by fire and water as already described. But the large masses were sometimes attacked with hammer-stones and without the help of fire. On the cliff already mentioned, some 20 ft. up on the vertical face, and far beyond the reach of fire, some old-time stone-knapper has been at work with a pebble hammer. He has done nothing more, however, than remove the outer weathered coating.

These two are the only methods of obtaining stone of which there are any traces at the Rush Pool. No signs of cutting or sawing were observed in any part of the quarry.

The hammer-stones used at the quarry are, almost without exception, water-worn granite pebbles brought from Mackay's Bluff or from the Boulder Bank. They range in weight from a few ounces to half a hundred-weight. Many of them have traces of the brown oxidized surface that comes of exposure to salt water. The transport of the larger ones for many miles over streams, through bush, and across a high saddle must have presented great difficulties. By the cliff-foot they are especially numerous, and furnish the best proof of the long period over which the quarry must have been worked. It would, I believe, be possible to collect some hundreds of them.

Any other material than granite seems to have been rarely used. Only one hammer of quartz was observed. Rodingite, which is very similar in appearance and physical properties to gabbro, and which occurs in the bed of the Maitai, was not observed at all. This is singular, since gabbro was extensively used in the form of hammers by the primitive flint-workers of

Europe.* Rodingite is, however, a favourite material for the finishing-work called "pecking," and, in the form of small, almost spherical, boulders, is frequently found on village-sites around Tasman Bay.

On none of the hammer-stones examined was there any sign of hafting. In a cleft on the summit of one of the crags two much-battered hammers were found, placed in *cache* by some Maori that never returned. They were further concealed by a large piece of the surrounding rock being placed over the cleft.

Some of the finer flaking must, I think, have been done with a punch; but no specimens of this implement were found. Possibly they were made of wood, as in the case of the Aztec punches; possibly of bone. Some of the unfinished adzes found have been "pecked" as a step preliminary to polishing. In far the greatest number of cases the tools would be roughed out at the Rush Pool, and then carried away to some kainga on the coast, there to be finished at leisure. But there must have been a certain proportion finished at the pool itself, for on the terrace already mentioned a number of polishers were found.

When digging for water in the mud of the basin late in a dry summer, Dr. S. A. Gibbs discovered a finished adze.† I have not heard of finished tools being found in any other part of the quarrying area. For the most part, the roughed-out blocks must have been carried away. This is exemplified by a large unfinished gouge which was found on the saddle between the unnamed north branch of the North Maitai and the Teal. Through this saddle the old Native track to Whakapuaka passed. At the confluence of the unnamed tributary and the main stream a large pile of small chips marks a much-used camping-place on this track.

From the data gathered a fairly detailed picture may be drawn of the ancient Maori adze-maker at work. He comes to the Rush Pool one of a party laden with baskets of food and loads of pebbles from the Bluff. He stows the food in one of the whares on the terrace above the pool, and goes out equipped with a fire-plough and a large granite pebble. The smaller boulders of argillite which could be broken by a hammer without the intervention of fire have been used up long ago, so he removes, by tapping, a patch of the outer coating from one of the masses, finds the stone suitable, and builds a fire against its base. Next he fetches water from the pool and pours it on the red-hot stone. The surface splinters, and the interior cracks. When it has cooled he attacks it with his haftless quartering-hammer, breaking it into blocks of suitable size. These he takes up to the terrace, where, with smaller pebbles, and perhaps with punches, he reduces them to the rough shape. The flakes struck off go to swell the pile, part of which is shown in Plate XII, fig. 2. The work may occupy him for several days, and he may perhaps "peck" and polish one or two of the tools that satisfy him more than ordinarily well, But he will have rejected some of the blocks after the first examination, and others will be thrown aside on account of flaws or unexpected hardness in the stone. In the meantime half the party will have been away trapping kakapo and weka on the slopes of the Dun, for in those days the thick tussock of the mineral belt, untouched for centuries by fire, must have afforded shelter to teeming bird-life.‡ On the return of the hunters he hides the hammer-stones that

* *E.g.*, at Pfahlbauten, Switzerland (*vide* Dr. Keller, "Lake Dwellings," p. 36).

† It is probable enough that others would be found in the same place. The Nelson Philosophical Institute might consider the proper exploration of the basin.

‡ For this suggestion, together with information as to the Native track, I have to thank Mr. F. F. C. Huddleston.

Fig. 1.—Stone-quarry, Rush Pool, near Nelson.

Fig. 2.—Stone-workers' "Workshop" at Rush Pool Quarry.

Face p. 328

are still unbroken, carefully packs his roughed-out tools, and turns his face down the spur to his home by the sea.

We have no record of the tribe that first quarried the stone about the Rush Pool, but we may feel fairly confident that it was used by Ngati-tu-mata-kokiri, and by their conquerors, Ngati-apa-ki-te-ra-to. Ngati-apa were the ruling tribe when D'Urville sailed by Mackay's Bluff in January, 1827, and, though they then knew the effects of firearms, they knew little about iron or iron implements.* I think we may fairly conclude that they were the last tribe to use the quarry extensively, and probably the last to use it at all, for in 1828 the Taranaki tribes swept down on Tasman Bay, conquering Ngati-apa, and afterwards settling over the whole land. They were armed with muskets, and were well acquainted with iron implements, which must have come to them in increasing quantities from Kapiti and Cloudy Bay. What tribe discovered and first made use of the stone will most probably never be known, but we may feel confident that the quarry was used over a long period of time. The granite boulders lying scattered over the surface could scarcely have been carried there in less than a century, and very probably indicate a much longer period. The great mass of flakes beside the pool is of itself no proof that the workings were long in existence, for a single Brandon flint-knapper can make between fifteen and sixteen thousand gun-flints in a week.† The ancient Maori, though not so quick a worker as that, could doubtless strike off a good many flakes in a short time.

Although we may be fairly sure that such whares as existed were on the flaking terrace overlooking the pool, there is no trace of their foundations. Neither is there any trace of shell or refuse heaps. On the northern slope, about 100 ft. below the track, there is a curious pit, probably of Maori origin. When cleared of the earth and stones that had fallen into it, it measured 5 ft. by 3 ft. by 4 ft. It may possibly have been a store-pit for fern-root.

The pool itself appears to be artificial. A low bank appears to have been thrown across the upper part of a gully, the pool in the basin thus cut off being fed by surface water. The advantage of a plentiful supply of water in the middle of the quarry area when quarrying is carried out by the use of fire and water must have presented themselves at once.

The Native tracks to and from the Rush Pool are indicated in the accompanying map. One of them, beginning at the present site of Nelson, follows the Maitai as far as the confluence of Sharland's Creek. Here it strikes up the spur between the creek and the river,‡ follows the bare ridge for a mile or two, and then, dropping down to the Maitai at Wilson's Flat, follows the valley again to the Forks. From this point onwards as far as Franklin's Flat it follows the line of Barnicoat's track—the "Old Mokitap." At Wilson's Flat a small patch of argillite boulders has been worked, while at the flat by the Forks granite boulders and argillite flakes indicate either a small quarry or a much-used camping-place.

A second track led up the stream by the present sawmill, over the saddle, into the Teal Valley, and thence to the coast. A large gouge, 18 in. long, was found on the saddle. The flakes that mark a camping-place at the commencement of this track have been mentioned already.

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* McNab, "Murihiku," p. 369.

† Evand, "Ancient Stone Implements," 2nd ed., p. 21.

‡ The narrowness of the Maitai Valley for some miles below Wilson's Flat rendered it almost impassable.

Art. L.—*The Moa—Legendary, Historical, and Geological: Why and when the Moa disappeared.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Society, August, 1913.*]

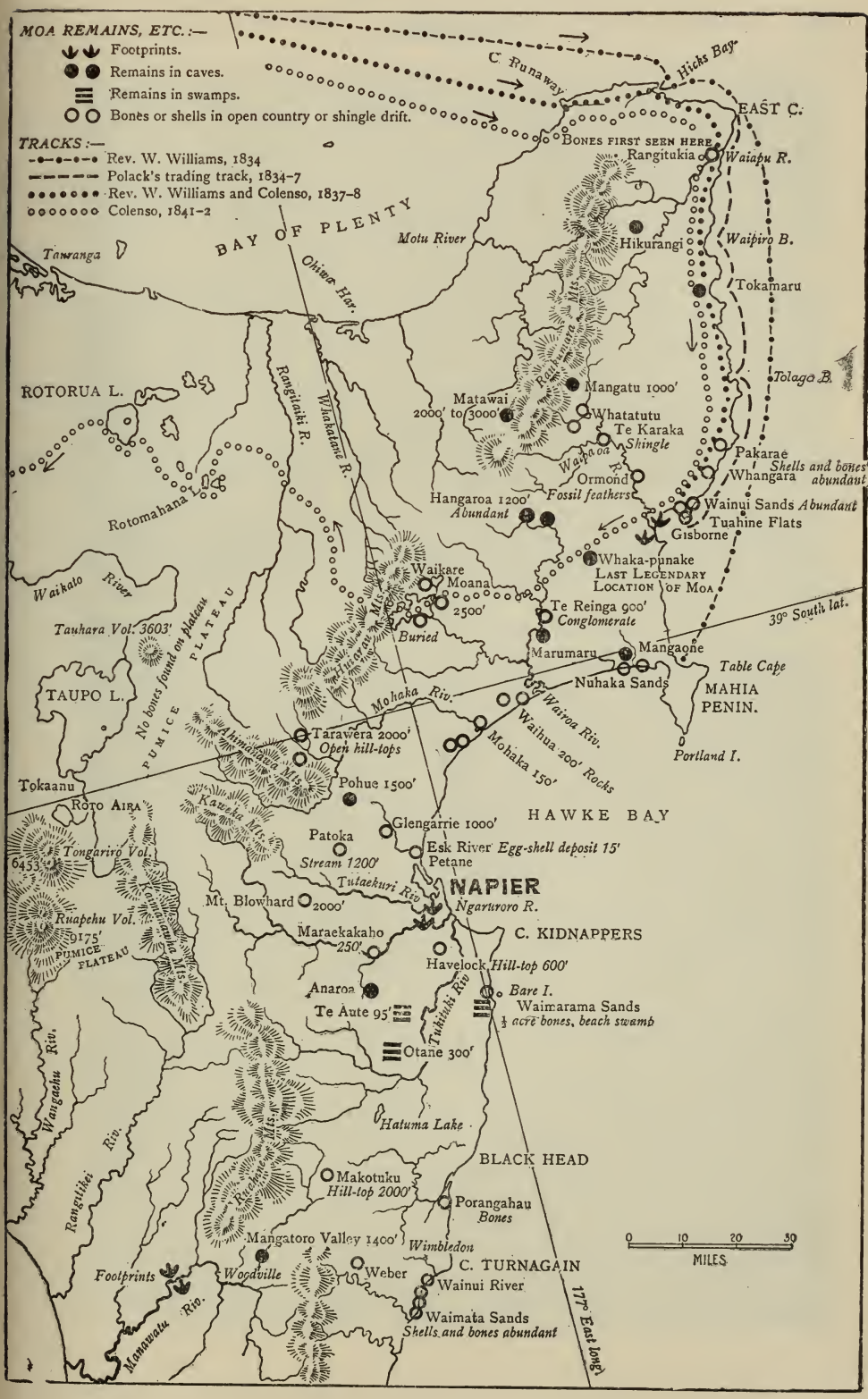
Few subjects occupy greater prominence in the earlier volumes of the "Transactions of the New Zealand Institute," and have created more interest among scientific men, than the published accounts of the bird known as the moa. Of the bird legends are few, Native information uncertain and unreliable, and the history of the discovery of its fossilized bones has never yet been satisfactorily settled.

The moa as a bird represents a remarkable past. There were giant birds in lands other than New Zealand during the days when the *Deinotherium* and *Mastodon* roamed at will in northern climes.

Why monster birds like the *Aepyornis* of Madagascar and the moa of this country were characteristic of areas south of the Equator contemporary with other monster forms of animals in northern lands is still a matter of surmise.

As far as I can trace, no mention is made by any of the earlier missionaries of fossil bones of any kind. Nicholas, who voyaged to New Zealand in the years 1814–15, and who published two volumes in 1817 of his travels and adventures, refers to the existence in New Zealand of a bird of the cassowary species. Thus, in vol. 2, page 225, he says, "From the feathers which line the garments of some of the chiefs it would appear that there is here a species of the cassowary, but we did not see any in our excursions. The feathers are precisely the same as those of the emu in New Holland, except being somewhat smaller." Of course, this has reference to the feathers of the *Apteryx*, or kiwi, which Nicholas did not see, nor does it appear to have attracted the attention of the missionaries until a later date.

Polack, a trader who spent two years or more along the east coast of the North Island between the years 1834–37, on his return to England published in the year 1838 two volumes relating many quaint things concerning New Zealand. On page 303 of vol. 1 he remarks of the North Island, "That a species of the emu, or a bird of the genus *Struthio*, formerly existed . . . I feel well assured, as several large fossil ossifications were shown to me when I was residing in the vicinity of the East Cape, said to have been found at the base of the inland mountain Ikorangi [Hikurangi]. The Natives add that in times long past they received the traditions that very large birds had existed, but the scarcity of animal food, as well as the easy method of entrapping them, has caused their extermination." Of the South Island Polack says (p. 307), "Yet, doubtless, the future ornithologist will be surprised by the discovery, among the hidden mountain-gorges and wilds of the Island of Victoria [*i.e.*, the South Island], many birds at present supposed to be no longer in existence. I feel assured from the many reports I received from the Natives that a species of Struthio still exists in that interesting land in parts which, perhaps, have never yet been trodden by man. Traditions are current among the elder Natives of atuas covered with hair, in the form of birds, having waylaid Native travellers among the forest wilds, vanquishing them with an overpowering strength, killing and devouring. The traditions are reported with an air of belief that carries


MOA REMAINS, ETC.:—
Footprints.
Remains in caves.
Remains in swamps.
Bones or shells in open country or shingle drift.
TRACKS:—
Rev. W. Williams, 1834
Polack's trading track, 1834–7
Rev. W. Williams and Colenso, 1837–8
Colenso, 1841–2
C. Runaway
Hicks Bay
EAST C.
BONES FIRST SEEN HERE
Rangitukia
Waiapu R.
Waipiro B.
Tokamaru
Tolaga B.
Pakarae
Shells and bones abundant
Whangara
Wainui Sands Abundant
Tuahine Flats
Gisborne
Whaka-punake
LAST LEGENDARY LOCATION OF MOA
39° South lat.
Mangaone
Table Cape
MAHIA PENIN.
Portland I.
Nuhaka Sands
Wairoa Riv.
Wailua 200' Rocks
Mohaka 150'
Mohaka Riv.
Te Reinga 900'
Conglomerate
Marumaru
Hikurangi
Motu River
BAY OF PLENTY
Tauranga
Ohiwe Har.
Rangitaiki R.
Whakatane R.
Rotorua Mts.
Matawai 2000' to 3000'
Mangatu 1000'
Whatatutu
Te Karaka
Shingle
Waipaoa R.
Ormond
Fossil feathers
Hangaroa 1200'
Abundant
ROTORUA L.
Rotomahana
Waikare Moana
2500'
Buried
Waikato River
Tauhara Vol. 3603'
No bones found on plateau
PUMICE PLATEAU
TAUPO L.
Tarawera 2000'
Open hill-tops
Ahimarama Mts.
Pohue 1500'
Tokaanu
ROTO AIRA
Kaweka Mts.
Tongariro Vol.
6453'
Ruapehu Vol.
9175'
PUMICE PLATEAU
Patoka
Stream 1200'
Glengarrie 1000'
Esk River
Egg-shell deposit 15'
Petane
HAWKE BAY
NAPIER
Tutaekuri Riv.
Ngaruroro R.
Mt. Blowhard 2000'
Maraekakaho 250'
C. KIDNAPPERS
Havelock
Hill-top 600'
Bare I.
Waimarama Sands
½ acre bones, beach swamp
Anaroa
Te Aute 95'
Tukituki Riv.
Otane 300'
Wangaehu Riv.
Rangitikei Riv.
Hatuma Lake
BLACK HEAD
Makotuku
Hill-top 2000'
Porangahau
Bones
Mangatoro Valley 1400'
Wimbledon
C. TURNAGAIN
Footprints
Woodville
Weber
Wainui River
Waimata Sands
Shells and bones abundant
Manawatu Riv.
177° East long.
0 10 20 30
MILES

conviction to the younger Natives, who take great delight in the marvellous and the improbable." Polack makes no mention of the word "moa" in his reference to fossil ossifications of a bird belonging to the genus *Struthio*, and it is strange that no reference occurs from the time when the missionaries reached the country, in 1814, up to the time when the Rev. William Williams and Mr. William Colenso took a holiday trip from the Bay of Islands along the East Coast, following the completion, printing, and publication of the New Testament in December, 1837.

Bishop Williams, of Napier, informs me in a letter that the Rev. William Williams first visited the East Coast to the south of East Cape in the year 1834. This being so, it is possible that he may have met Polack at Tolago Bay or elsewhere along the coast, and that he then heard of the fossil ossifications; but I can find no reference to this in any publication. Colenso was a born naturalist, and this fact may have suggested to the Rev. William Williams the advantage of being accompanied by Mr. Colenso during his second visit to the coast. But whatever the reason for the companionship of the Rev. William Williams (missionary, and editor of the first New Testament in Maori) and Mr. Colenso (the printer of that New Testament), the fact remains that previous to the date when the two started on their important journey together on the 1st January, 1838, no missionary or other person appears to have interested himself in the "fossil ossifications" such as Polack states he saw along the East Coast during his residence between the years 1834–37.

The gradual spread of information in England and elsewhere following the publications of Nicholas and Polack naturally increased the interest of zoologists in the flora and fauna of New Zealand. Every bit of information that it was possible to glean about the country was collected, in the hope of obtaining for Great Britain some of the credit that naturally marks a country by the discoveries of its scientific workers. The mere reference by Nicholas that a struthious bird existed in the country, and subsequent reference by Polack to the *Apteryx* and "fossil ossifications" of a former *Struthio*, sufficed to whet the imagination of zoologists in England, and to direct their attention to the importance of New Zealand as a land to be studied and exploited by scientific workers. In January, 1838, Polack's books could not have reached this country, but the frequent reference in the English newspapers posted to New Zealand sufficed to arouse the attention of missionaries and others to the many objects of Maori workmanship and the wonders in natural history around them. These, while differing from what was common in the Home-land, provided valuable material for scientific inquiry and research.

The years extending from 1837 to 1843 are particularly interesting, as representing an important page in the history of this country. The cities of Auckland and Wellington were founded. The Treaty of Waitangi was signed, making New Zealand an integral part of the British Empire. Captain Hobson, the first Governor of the new colony, was appointed, and many scientific men visited the country whose names to-day are world-wide. Among those may be named Dieffenbach, Dr. Sinclair, Sir John Franklin, Allan Cunningham, the late Sir Joseph Hooker, F.R.S., and—greatest of all—Darwin. All these visited New Zealand within the years named; and, to add still further to the growing importance of the country, the British House of Commons held an inquiry into certain matters connected with the growing lawlessness of the "flotsam and jetsam" that had reached New Zealand from Australia and the surrounding islands.

It was in November, 1839, that Professor Owen read his celebrated paper before the Zoological Society of London describing a bone new to science that had been purchased from a Mr. Rule, who said it had been brought by him from New Zealand. The bone was an imperfect one, but Owen recognized it as the bone of a bird, and boldly announced the former and perhaps present existence of a huge bird in New Zealand. We may suppose that Owen at this time had read Polack's volumes, which were published in 1838, containing reference to "large fossil ossifications" that had been seen in the vicinity of the East Cape.

It is important to keep in mind the month of November, 1839, in connection with Professor Owen's first paper. Owen showed that the "fossil ossifications" referred to by Polack in his book were none other than those of birds, and that the traditions handed down by the Natives to the effect that "in time long past . . . very large birds had existed" in the country was true in fact. Owen had said in his famous paper that a bird such as he described might be still living, but the Native tradition received in times long past by ancestors of the Natives who told Polack affirmed the bird had been exterminated in times long past in order to provide food for the Natives.

Nearly two years before Professor Owen's first paper was read the Rev. William Williams and Mr. Colenso, as explained above, had travelled down the east coast of the North Island. Mr. Colenso's account of the journey is available for reference (Trans. N.Z. Inst., vol. 12, p. 63). The two travellers started from the Bay of Islands on the 1st January, and returned on the 13th February, 1838.

Here is what Mr. Colenso wrote in 1842 for the "Tasmanian Journal," referring to the information first gleaned by him of "fossil ossifications," to be known subsequently as "moa-bones": "During the summer 1838 I accompanied the Rev. W. Williams on a visit to the tribes inhabiting the East Coast district. Whilst at Waiapu [*vide* map], a thickly inhabited locality about twenty miles south-west from the East Cape, I heard from the Natives of a certain monstrous animal. Whilst some said it was a bird and others 'a person,' all agreed that it was called 'moa'; that in general appearance it somewhat resembled an immense domestic cock, with the difference, however, of its having a face like a man; that it dwelt in a cavern in a precipitious side of a mountain; that it lived on air; and that it was guarded or attended by two immense tuataras, who, Argus-like, kept incessant watch while the moa slept; also that if any one ventured to approach the dwelling of this wonderful creature he would be invariably trampled on and killed by it."

This account differs somewhat from that given by Polack, but it suggests also a reference to what the latter writer states of the birds found in the South Island that were covered with hair, and that they killed and devoured human beings. Although differing in details, the statements suffice to show that throughout the East Coast traditions existed among the Natives of the former existence of strange and curious animals. The discovery of large bones in the river-beds confirmed the Natives in their opinion, and especially so as there were no animals in the country larger than the native dog.

There appears to be no doubt that Mr. Rule was the first person to carry a moa-bone to England and bring it under the notice of scientific men; and it was this same bone that enabled Professor Owen to build up his imaginary bird, and to announce to a wondering world that "there had existed and perhaps still exists in New Zealand a race of struthious

birds of larger and more colossal size than the ostrich or any known species." This paper, as already explained, was read on the 12th November, 1839, and the Rev. William Williams and Mr. Colenso were at Waiapu in January, 1838. Polack's book was published in 1838, and so it could not possibly have been seen by either Williams or Colenso; and we have the latter's statement that he did not see Polack's book until many years following its publication. Napier, Gisborne, and the East Coast generally are so closely connected with the early history of the fossil moa that it is of some importance to state as concisely as possible the historical sequence of events concerning the parties who played so prominent and honourable a part in making known to the scientific world the truth of Owen's generalization, that there had existed in New Zealand a *Struthio* bird equal in size to the ostrich.

In order to arouse interest in the subject of Professor Owen's paper among the settlers in New Zealand, it is said that a hundred or more additional copies of Owen's first paper were printed by the Zoological Society for distribution to the colonies; but the assurance is given by Colenso in Trans. N.Z. Inst., vol. 24, p. 474, that he never saw Owen's paper or heard of it. "Now, I positively affirm," he says, "that I not only never saw Professor Owen's *first* memoir, but that I had never once heard of it; neither did I ever hear of any resident in New Zealand who had seen it." But Colenso must have heard of the subject as dealt with by Owen in his paper, because the newspapers were full of the new wonder from New Zealand, and interest was aroused among the settlers throughout the whole of the two Islands.

Up to the year 1838, as far as I can find, no individuals living in New Zealand other than Allan Cunningham, botanist, and William Colenso, printer, had interested themselves in natural science. In the Proceedings of the Church Missionary Society there is a letter from Mr. Colenso in which he suggests how valuable and welcome would be the gift of a microscope, and it is evident from his earliest writings on botany and natural history that he was a keen and careful collector of natural-history specimens from the time of his arrival in New Zealand to the close of 1834.

Dieffenbach did not arrive in the country until 1839, and, although he states that a Native chief tried to dissuade him from ascending Mount Egmont by saying "it was guarded by a moa," he does not appear to have heard either legend or fact of the moa during his journey from Taranaki to the Bay of Islands. During Dieffenbach's stay in the Bay of Islands he resided next door to Colenso, and it was at this time that Dieffenbach met the Rev. R. Taylor, who had recently returned from the East Coast in the company of the Rev. William Williams. These missionaries started on their journey in January, 1839 — a year after Colenso's first visit — and returned on the 13th February. This was the Rev. Mr. Taylor's first trip to the East Coast, for he was a recent arrival in the country; but he is said to have succeeded in obtaining a fossil toe-bone, which, with other bones, Dieffenbach saw. It appears that small parcels of broken bones had been sent to Mr. Colenso (*a*) by the Rev. William Williams, and (*b*) by the Maori teachers who had been sent to the East Coast after the return of Messrs. Williams and Colenso in February, 1838. Colenso says he told the "Maori teachers," when starting to the East Coast, to inquire for fossil bones, and to send them to him at his home in the Bay of Islands whenever opportunity should offer. Hence Dieffenbach saw the toe-bone found by the Rev. R. Taylor and the bones belonging to Colenso sent to

him by the Maori teachers and the Rev. William Williams, both being obtained in the year 1839. (*Vide* map.)

The interval that elapsed between the reading of Owen's first and second papers was an active one in New Zealand in the way of collecting bones. Colenso paid a second visit to the East Coast in the summer of 1841–42 (*vide* map). He started from the Bay of Islands on Friday, the 19th November, on board a little vessel bound for Poverty Bay. He, however, landed at Wharekahike (now known as Hicks Bay), between Cape Runaway and the East Cape. He continued his journey southward to Rangitukia, a large Native settlement of the Ngatiporou Tribe on the left bank of the Waiapu River. Here he obtained "several fossil bones of the moa" (five femora, one tibia, and one undetermined).* These were the first moa-bones actually collected by Mr. Colenso. He continued his journey southward along the coast to Poverty Bay, where he met the Rev. William Williams, now made Archdeacon, and who had gone to reside at Turanga (Gisborne) at the beginning of 1841. The Archdeacon had a number of moa-bones which had been obtained from the Natives. These had been collected with the intention of sending to Professor Buckland, at Oxford. Colenso states† that he gave some of the bones collected by himself to the Archdeacon. It is reasonable to suppose that mutual exchanges were made at this time. Colenso went inland from Poverty Bay, following the present inland Gisborne–Wairoa Road as far as Te Reinga Falls in the Hangaroa River (*vide* map). His inquiries for moa-bones were frequent as he passed round the famous Whakapunake headland of limestone, where, according to tradition, the moa still lived in a cave! (*Vide* map.) He was told just what Maoris always tell whenever they are ignorant—that the information he sought of the moa would be obtained from some other named person in another locality. Interest, however, was aroused by his inquiries for bones, and observation was quickened when it was known that money would be given by the missionary living at Turanga to those who should find bones and take them to him. Colenso tells us that many bones were taken to the Archdeacon, but that he himself could not obtain any information other than legendary about the moa, which the Natives near Whakapunake now said lived in the Wai-iti Mountains! Colenso undoubtedly made a brave effort at this time to discover facts concerning the moa as known to the Maoris, but his efforts were unsuccessful. The facts gleaned along the coast during his progress to Poverty Bay, and the legends common to the East Coast district, were not increased during his remarkable journey through the heart of the North Island.

During the year 1842 Archdeacon Williams sent a collection of bones to Professor Buckland, at Oxford. Some of these bones consisted of a pair of femora collected by Colenso at the Waiapu River, near Rangitukia, where, as already stated, Colenso obtained five femora, one tibia, and one bone undetermined. On returning to the Bay of Islands Colenso also set about making up a collection of moa-bones to send to his friend Sir W. J. Hooker for Professor Owen, and at the same time he wrote an account of his views on the moa, and a monograph on some New Zealand ferns. The former he sent to the editor of the "Tasmanian Journal of Science," and the latter to Sir W. J. Hooker. Colenso's paper on the moa was sent to the editor

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* "Memoranda of an Excursion in New Zealand." "Tasmanian Journal," vol. 4, p. 220.

† Trans. N.Z. Inst., vol. 12, p. 70.

of the "Tasmanian Journal of Science" early in the year 1842, and was acknowledged on the 6th August, as follows :—

My Dear Sir,— Hobart, V.D.L., 6th August, 1842.

I believe Mr. Henslow acknowledged your two papers upon the ferns of New Zealand and upon the fossil bones (which are indeed a very remarkable discovery). They were laid before the society at the last meeting (3rd August), and the next number, now in the course of printing, will contain your paper on ferns; the other we reserve for the succeeding number. We are not restricted to lithography by the expense, but the difficulty of getting the things done properly. However, I hope your illustrations will be to your satisfaction, as they are already in the workmen's hands. I enclose a copy of No. 4, and will not forget to send four copies of No. 5 when published. Communications may be addressed to me under cover of Sir J. Franklin, as I have undertaken the duties of secretary of the society.—Believe me, &c.,

To William Colenso, Esq. I. P. Gell.

The original of this letter is in my possession. Here it is clearly shown that Colenso sent his papers on "fossil bones" to the Tasmanian Society in Hobart soon after his return from what was at the time a very remarkable and successful journey by way of the East Coast, thence inland to Waikaremoana, through the Urewera Country to Rotomahana and Rotorua, and onward north to the Bay of Islands.

Colenso's paper on the moa appeared in the "Tasmanian Journal of Science" in 1843, and Professor Owen republished it in the "Zoological Magazine" (vol. 19, p. 81) the following year. This fact of republication by Professor Owen suffices to show that the paper was one of scientific value. Between the time of Colenso's writing his paper on the moa for the "Tasmanian Journal of Science" and Owen's republication of it a letter had been written by Owen himself to Mr. Colenso on the recommendation of Sir Joseph Hooker, and from this it is possible to correlate all the facts connected with the receipt of moa-bones in England up to the time of the professor's writing :—

Royal College of Surgeons,

Sir,— Lincoln's Inn Fields, 23rd October, 1843.

I am encouraged by Sir William Hooker to hope that you may interest yourself in transmitting me information and specimens relative to a point in natural history which I have been for some years endeavouring to elucidate—viz., the nature and affinities of the gigantic bird which appears to have become extinct, like the *Dodo* of Mauritius, within the historical period in the North Island of New Zealand. The Proceedings of the Zoological Society for January, 1843, which I take the liberty to transmit, will put you in possession of the amount of information which I had obtained on the subject of the *Dinornis* of that period.

I have subsequently obtained, by comparison of the specimens transmitted to Dr. Buckland by the Rev. Wm. Williams, good evidence of not less than four species of *Dinornis*, the bones of which have been obtained from the beds of streams descending from the mountains into Poverty Bay. These species are at present indicated by bones of the leg. No part of the head has yet reached England [note 23rd October, 1843], nor any trace of wings or rib-bones. The latter I conjecture to have been disproportionately small, as in the *Apteryx*. Every additional bone of the *Dinornis* would be of great value and utility in recomposing the different species. I have, for example, now got the femur and metatarsus of one species, without the tibia, or longest bone of the leg; in another species I have the tibia, but not the femur, or thigh-bone.

You will see that Mr. Cotton refers to a report which Mr. Williams had heard relative to the existence of the great species at the present time in the Middle Island. I should be glad to have any further information on that point which may have reached you.

With the notice of the *Dinornis* I send also an abstract of my anatomical description of the kiwi, or *Apteryx*, of New Zealand. The probability that the fate of this genus may soon be that of the *Dinornis* has induced me to spare no pains to secure a record of its organization. Hitherto the specimens (two) I have received have not reached me in a state fit for the dissection of the nerves. For this purpose a recently killed

Apteryx should be immersed in a strong colourless spirit, the skull having been carefully cut open and partly removed with a penknife to allow the spirit to get to the brain. An opening should be cut into the belly, and the spirit poured in there and down the throat. If after some weeks' immersion the spirit were changed the bird would without doubt arrive in such a state as would allow me to complete my monograph. . . .

For the honour of our country the scientific account of the rarities of our remote colonies should emanate from England. We have too often been indebted to foreigners for such information. . . .

As soon as I have published the memoir I am now preparing on the *Dinornis* I shall forward it to the Rev. Wm. Williams and yourself, and meanwhile remain,—
Yours, &c., RICHARD OWEN.

This letter, written on the 23rd October, 1843, is initialled by Colenso as having been received on the 17th January, 1846, or two years three months afterwards, and was answered on the 20th January, three days after its receipt. The delay may have arisen owing to the trouble with Hone Heke in the Bay of Islands, and to the circumstance that Colenso removed to Hawke's Bay about this time.

The two letters here quoted show—First, that Colenso's paper on the moa was written immediately following his return from his second journey along the East Coast in April, 1842, and acknowledged by the editor of the "Tasmanian Journal" in August; second, that Owen's second paper appeared in January, 1843; third, that between the appearance of Owen's second paper and his letter to Colenso of the 23rd October, 1843, Professor Owen had received from Buckland the collection of bones forwarded by the Rev. William Williams; fourth, that at the time of writing to Colenso Professor Owen was occupied upon a third paper on the *Dinornis*, a copy of which he promised to send to Colenso when sending one to the Rev. William Williams, who was most interested; fifth, that Colenso could not have obtained any facts connected with Owen's first paper at the time of writing his own paper; sixth, that Colenso's paper was republished by Owen in the "Zoological Magazine" (vol. 19, p. 81).

Reference has already been made to Dieffenbach and the Rev. Richard Taylor, as quoted by Colenso. It is necessary, however, to quote what each one says in order to avoid even the appearance of bias. Dieffenbach, in vol. 2 of his book on "New Zealand," page 195, says, "To this order probably belongs a bird, now extinct, called Moa (or Movie) by the Natives. The evidences are, a bone very little fossilized, which was brought from New Zealand by Mr. Rule to Mr. Gray, and by him sent to Professor Richard Owen (Proc. Zool. Soc., 1839, p. 169). I possess drawings of similar bones, and of what may possibly be a claw, which are in the collection of the Rev. Richard Taylor, in Waimate. They are found on the east coast of the Northern Island of New Zealand, and are brought down by rivulets from a neighbouring mountain called Hikorangi." In the year 1855 the Rev. R. Taylor published a book bearing the title "New Zealand and its Inhabitants." The following reference to the moa is taken from page 396: "But of all the birds that have once existed in New Zealand, by far the most remarkable is the moa (*Dinornis* of Owen). Perhaps it was the largest bird which ever had existence, at least during the more recent period of the earth's history; and it is by no means certain that it is even now extinct! I first discovered its remains in 1839, at Tauranga [Turanga], and now Waiapu."

Now, Colenso, so it is stated, lived next door to Dieffenbach; but the latter makes no mention of Colenso, and it is doubtful whether Colenso had any bones of the moa at the time of Dieffenbach's stay, for he had not

started on his second journey along the coast. In support of this suggestion is should be mentioned that Colenso, in the "Tasmanian Journal" (vol. 2, p. 7) refers to the fact that on the return of the Revs. William Williams and Taylor from the coast the latter carried with him "a part of a fossil toe (or, rather, claw) of some gigantic bird of former days."

In vol. 5, page 97, of the "Transactions of the New Zealand Institute" Mr. Taylor relates how he found a portion of a large bone at Waiapu, near East Cape, in 1839: "When in the house of a Native at Waiapu with the Rev. William Williams I noticed the fragment of a large bone stuck to the ceiling. I took it down, supposing at first it was human, but when I saw its cancellated structure I handed it over to my companion . . . asking him if he did not think it was a bird's bone. He laughed at the idea, and said, 'What kind of a bird could there be to have so large a bone?' . . . The Natives said it was a bone of the tarepo, a very large bird which lived on the top of Hikurangi, and that they made their largest fish-hooks from its bones." Nothing is said about the finding of a claw, as related by Dieffenbach and Colenso, Mr. Taylor's purpose, apparently, being to show that he found the first bone recorded in New Zealand. This bone, Mr. Taylor says, the chief readily gave him for a little tobacco. It is stated, further, that the bone was sent to Professor Owen through Sir Everard Home, but that it did not reach the professor for some time afterwards, when Owen had already announced in his famous paper the existence of a former gigantic bird in New Zealand, basing his conclusions on the specimen carried to England by Mr. Rule.

There is no reason to doubt the statement as to the finding of the bone in the ceiling by the Rev. Mr. Taylor; but in order to obtain the best available information concerning the earliest discovery of moa-bones in this country I have obtained from Bishop Leonard Williams, who is the son of the late Rev. William Williams, subsequently first Bishop of Waiapu, a memorandum on "Moa Remains," and concerning the discovery of which his late father was so closely connected. The legendary history to which the bishop refers in his letter affords no satisfactory evidence as to whether a long time or a short one has elapsed since the moa disappeared, or whether the moa and the Maori were contemporaneous. It can hardly be supposed that the disappearance of the moa, which was distributed throughout both Islands, occurred synchronously, or that the moa of the North Island disappeared synchronously, unless from some physical cause other than by man's means. Bishop Williams is of the opinion that the moa's disappearance is of recent date, and he is supported in his contention by men like the late Sir James Hector, Professor Hutton, and, latest of all, Professor A. Quatrefages.* On the other hand, Sir Julius von Haast, the Hon. W. B. D. Mantell, F.G.S., W. Colenso, F.R.S., and Mr. Tregear (the former from geological evidence, the last from etymological), and many others have expressed the opinion that the moa disappeared either earlier than the advent of the Maoris into the country or very soon afterwards.

The first actual information extant concerning the legendary history surrounding what are now termed moa-bones is the account given by Polack. He states, as already explained, that he "saw several large fossil ossifications, and that in times long past Natives received the tradition that very large birds had existed in the country." Further, that traditions

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*Trans. N.Z. Inst., vol. 25, p. 17.

then current among the elder Natives related how atuas covered with hair, in the form of birds, dwelt in the forest wilds, and killed and devoured human beings whenever the opportunity arose. Here fact and legend meet. The bones have been proved to be those of birds, and the information had come in the long past from Natives who "received the tradition of the former existence of birds." The fact that atuas and birds are mixed in the legendary lore is very noticeable; but one would suppose that had the bird been generally known to the Natives of either Island the same name would have been applied to it. Polack makes no mention of the name of the legendary bird. The Rev. Mr. Taylor termed it "tarepo." In London Mr. Rule gave the name of the supposed bird as "movie," and Mr. Colenso, in his paper that appeared in the "Tasmanian Journal of Science" in 1843, states that when at Waiapu (near East Cape of the North Island) during the summer of 1838 along with the Rev. William Williams he first heard of a certain monstrous animal. Some said a bird, some a person; all agreed it was a moa—a domestic cock that had the face of a man and dwelt in a cavern in the precipitous side of a mountain; that it lived on air, and that it was guarded by two immense tuatara, which watched whilst the moa slept. Again, in vol. 11 of the Transactions, page 83, Colenso writes, "Yet not a single vestige of any osteological remains of any animal of the saurian kind has ever yet been discovered! While, on the other hand, the fossil remains of many large and extinct struthious birds of several genera and species, and commonly known in the lump as 'moa,' are to be met with in great abundance; and yet of these realities there are neither creditable history, nor curious legendary tale, nor myth nor fable that I have ever been able to lay hold of!"

Whakapunake, a bold scarp of limestone due south of Poverty Bay, was spoken of as the residence of the creature. The Natives were afraid of the moa. Colenso endeavoured to find out more about the moa on his second visit to the East Coast in 1841–42, but although he passed round Whakapunake and proceeded to the interior of the Island he was unable to gather any information, either legendary or other, about the moa.

It will be noticed that there is a general agreement between Colenso and Polack in their description of the atuas in the shape of birds that at one time existed in the country. The fact that such traditions alone remained suffice to show that the moa had disappeared from the North Island at least anterior to the arrival of any settlers, missionaries, or traders.

Bishop L. Williams refers to the legendary footsteps of a celebrated ancestor of the Maori—Rongokako; but I prefer to accept the evidence of Panopa Waihopi, the principal chief residing at Te Karaka, whose illuminating letter (when read in the light of Colenso's reference below) appeared in the *Poverty Bay Herald* of the 30th May, 1912. This letter was written after the alleged discovery—rediscovery, it should have been (see Transactions, &c.)—of moa-footprints at the mouth of the Waikanae Stream as you enter between the pier-heads into the Turanganui River, Gisborne. The following is a copy of the letter:—

SIR,—

I wish to inform you for the benefit of those who discredit the discovery of the moa-footmarks on the Waikanae. I am now approaching my eightieth birthday. In the year 1850 I was shown the very same footprints by Kahutia te Rangi, Lady Carroll's grandfather, and was told they were the footprints of Rongokako, of Maori historical fame. Kahutia's people before that knew of the same footprints. The footprints are therefore not moas', but Rongokako's.

When Colenso made his second visit to the East Coast, as related in the "Tasmanian Journal of Science," he remarks that after passing Te Kawakawa (Hicks Bay) "the clayey rocks had been so acted upon by the sea as to be worn quite flat in many places, stretching into a continuous layer of rock nearly a mile in length. Here in a clayey rock near high-water mark the Natives show the impression of the foot of Rongokako, one of their illustrious progenitors, the print of his other foot made in striding hence being near Poverty Bay, a distance of more than fifty miles" [100 miles ?]. Many marvellous exploits are recorded of Rongokako in the legendary realms of the Maori, but it is curious that the statement made by Colenso in 1842 should be substantiated by Panapa Waihopi in 1912. The statement of the Native chief is another instance as showing that the so-called footmarks of Rongokako and the footprints of the moa were unknown to the Maoris of the North Island except as mere legends.

In vol. 5, page 95, of the Transactions the Rev. Mr. Taylor says that on inquiring from the Natives as to what kind of bird the bone belonged which he had found in a Native house, he was informed "it was the bone of the tarepo—a very large bird which lived on the top of Hikurangi, the highest mountain on the East Coast. . . . I then inquired whether the bird was still to be met with, and was told there was one of immense size which lived in a cave and was guarded by a large lizard, and that the bird was always standing on one leg!"

On the other hand, Colenso (vol. 12 of the Transactions, page 81) says an old chief of the coast informed him that "anciently the land was burnt up by the fire of Tamatea. Then it was that the big living things, together with the moas, were all burnt. Two moas, however, survived with difficulty that destruction, but only two; one of these lived at Te Wai-iti Mountains (in the interior) and one at Whakapunake. The feather of this one at Whakapunake has been seen, and was preserved as a plume decoration for the heads of the dead chiefs of note. The name of the feather was Ko-te-rau-o-Piopio (the special plume of Piopio). The forefathers of the Maoris heard of the moa, but they never saw its body, only its bones." This statement agrees entirely with what I have been able to gather from the Natives in the vicinity of Whakapunake, at the foot of which I have passed in going to and from Poverty Bay during the past thirty-five years. Invariably the same answer is given in reply to inquiries: "In a cave near the top of Whakapunake the last moa lived, and his feathers were used on great occasions; but this was a long time ago."

As showing how the traditional lore is passed on from father to son, the following account was related to me on the 16th July, 1912, by Urupeni Puhara, aged eighty-eight, an old chief still living at Pakipaki: The "moa" was not the name by which the great bird that lived in this country was known to my ancestors. The name was "Te Kura," or the red bird; and it was only known as "moa" after the pakehas said so. Te Kura was known to all ancient people, and was handed down from father to son, who spoke about the big bird that was as high as the top of the door (pointing to the door of the room in which we were sitting). Its legs were thick as those of a bullock. Neither his father nor grandfather had seen Te Kura, but it had been told to them, and tales were told of what it did. He did not know how it was caught or snared, nor had he seen or heard of moa's eggs, and knew nothing of its footmarks. The moa lived, he had heard, all over the North Island, but they disappeared after the coming of Tamatea, who set fire to the land. The fire was not the same as our fire, but embers were

sent by Rangi. The signs of the fire are still to be seen where red rocks like red berries are found. The place is called Te Pua-o-te-roku, or the Garden of Berries. The man that brought the moa to New Zealand was Rua Kaponga. Tamatea was the son of Rongokako, and he married Hine Maurea, or Muri Whenua.

Knowing that Colonel Porter, C.B., of Gisborne, had a wide acquaintance with Maori history and legendary lore, I drew his attention to Urupeni Puhara's account of the moa, particularly with reference to Te Pua-o-te-roku, and he replied to my letter thus :—

DEAR MR. HILL.— Heatherlea, Gisborne, 25th July, 1912.

Thanks for yours of the 18th ultimo. I quite appreciate the scientific interest you take in Maori legendary. *Re* the old chief's statement, the word "*manu*," as you know, means "bird," and some version of Rongokako says "his *manu*"; then on closer inquiry they say "like a kiwi, only bigger." None seem to have in mind the moa. The old man's story about the pakeha having so named the moa recalls an amusing story I heard on the train years ago between Napier and Wellington. An elderly gentleman *en tour* was questioning a well-educated half-caste on the original of the name "moa." The reply was, "Oh, the Maori had no name for it, only '*manu*,' and that it was after the pakeha came and discovered the skeleton remains throughout the country they exclaimed, 'More bones! More bones!' Hence the name 'moa' by the Maoris."

I was highly amused, but did not intervene. It is strange that there is no authentic record of the moa in song or legend; only one proverb, "*Ngaro a moa*"—lost like the moa. This tends to prove they had "the name," at all events.

There is a piece of forest land on the Mata River, near Hikurangi, called Rua-o-te-roku, noted for the redness of its rocks and berries; in former days a great pigeon-hunting ground.

Re the embers destroying the moa, I did hear that theory among Ngaitahu in the South Island, who said fires fell from heaven, set fire to and denuded the country of forests, so destroying the moa, whose remains are found only in caves and swamps, where they sought refuge. I have not heard any story of the kind in the North Island, which has always been so forest-clad.—Yours, &c., P. PORTER.

The historical facts and legendary references already presented show—(*a*) that fossil bones are first described as having been seen and subsequently collected along the east coast of the North Island; (*b*) that the first-known fossil bone taken to England from New Zealand was taken by a Mr. Rule, from the East Coast; (*c*) that the Revs. William Williams and R. Taylor early in 1839 obtained a bone in the vicinity of Waiapu, and that Colenso obtained some imperfect bones about the same time from Native teachers who were sent to the East Coast following the return of Messrs. W. Williams and Colenso early in 1838; (*d*) that Mr. W. Colenso obtained numerous bones on his second visit to the coast in 1841–42, and, reaching Poverty Bay, found the Rev. William Williams (now Archdeacon) had commenced to collect bones in order to send them to Dr. Buckland at Oxford; (*e*) that Mr. Colenso was certainly the first person in New Zealand who wrote a scientific account of the moa, early in 1842; (*f*) that Professor Owen read his first paper in 1839, and wrote a letter to Colenso in October, 1843, long after Colenso's first paper was published in the "Tasmanian Journal of Science," and before the publication of Owen's second paper; (*g*) that the legendary lore of the Natives, without exception, connects the moa throughout the East Coast with atuas and Rongokako and Tamatea, who are fabled ancestors of the Maoris; (*h*) that not a single Maori known to the missionaries and early settlers ever saw or heard of a moa, or of its having been seen by any of their ancestors; (*i*) that Polack's statement as to the great antiquity of the "fossil ossifications" has stood the test against every theory, palaeontological or otherwise, of moas being possibly living in recesses of mountains or forests in one or other of the Islands of New Zealand.

Geological.

Scattered throughout the "Transactions of the New Zealand Institute" are numerous papers dealing with the moa. Some refer merely to the discovery of bones in middens, in banks of streams, caves, and so on; several of great importance refer to the structure and general anatomy; and several deal with the geological distribution.

When at Home two years ago I made several special visits to the Geological and Palaeontological Section, Natural History Branch of the British Museum. Here are found, in the class *Aves*, the orders *Dinornithiformes* and *Aepyornithiformes*, which include fossil remains of the New Zealand moa and Madagascar *Aepyornis*. The latter bear a close resemblance to the moa-structure of this country. The Madagascar fossil bird remains belong to a recent geological period, and the opinion as to the age of the New Zealand moas is expressed by the authorities as follows: "The situation and state of preservation of the abundant remains which have been found indicate that they existed till comparatively recent times, and were probably exterminated by the present Maori inhabitants of the Islands. Feathers which have been found associated with the bones show the presence of a large after-shaft. . . . The moas are represented by several genera, the largest member being *Dinornis maximus*. . . . Some species seem to have survived until about four or five hundred years ago, or even later in the South Island."

The context will deal only with the East Coast district of the North Island. For thirty-five years I have been travelling between Cape Turnagain and East Cape on the coast, and Ruahine and Te Wai-iti Ranges on the west. This represents the classic ground of the earlier missionaries and collectors of moa-bones. For a number of years, and up to the time of his death, I was on terms of the closest intimacy with the late Rev. William Colenso, F.R.S., and my familiarity with the geological structure of the district where traces of the moa have been observed places me in a favourable position in dealing with the geological distribution of the moa in terms of time.

For years records have been carefully kept of the various places where bones, or egg-shells, footprints, and feather-markings have been found, and as a result a map has been constructed showing the localities where moa-remains occur *in situ*, and the details are entered here for the benefit of future workers. The East Coast district extends for over three hundred miles from north to south, and about a hundred miles at its greatest width. The district presents features of its own that are characteristic.

Polack, who first saw "fossil ossifications" and related the legendary lore concerning them, was a mere trader and collector of curios, but he was an observant man, and suggested the rapid disappearance of certain birds whose wings were short or were altogether absent. All the earlier writers and collectors refer to the bones as being found in places where water has been in motion. Thus the Rev. Williams, in 1842, says, "None of the bones are found on dry land, but are all gathered from beds and banks of fresh-water rivers, buried a little distance in the mud." Dieffenbach says, "They are found on the east coast of the Northern Island of New Zealand, and are brought down by rivulets from a neighbouring mountain called Hikorangi." Polack says the bones he saw were found near a mountain called Ikorangi, far in the interior. He makes no mention of being found in the beds of streams.

Since the days of the first findings of the bones of the moa the South Island has produced even larger collections of bones than the North, and the information has been such as to suggest to persons in the South Island its comparatively late disappearance.

In vol. 1 of the Transactions the Hon. W. B. D. Mantell infers from an examination of Maori ovens that cannibalism prevailed at the time the moas were used for food; and Dr. Hector alluded to "the profusion of moa-egg shells in the ovens of the interior, which showed that eggs must have been prized as food, and that their consumption must have soon led to the extinction of the birds."

There is no such evidence as this along the East Coast. Traces of middens are common everywhere, and all the evidences of a long Native settlement are abundant. So likewise there is evidence of the existence of the moa and scores of other birds; but a careful examination satisfies me that the moa dwelt along the coast before the advent of man, and that no disturbing causes from the human side tended to their disappearance. The sand-dunes along the coast where the traces of moa-bones, shells, moa-chick bones, &c., are common require to be carefully studied. The dunes do not consist of a single series of sands, but two, and sometimes three, separate deposits are traceable. The sand and clay accumulations extend from the foothills over an extensive shelving area of low rocks—remnants of land that the sea has borne away and covered with the clay-sands from the greensands and limestones that are found along the coast. These sands represent an accumulation over a long period of years, during which time even the physical features of the country have changed. The lower beds present the appearance of having been occupied by birds without intrusion of an enemy, for there are many varieties of bones, and no trace of occupation by human beings. The middle beds contain obsidian, bones of the walrus, fish-bones, human bones, and shells, whilst the upper sands represent blown or moving sands which soon cover the other beds, and make an appearance as if all the beds belong to one and the same series. It can readily be understood how the middle and upper sands may get mixed with the lower by wearing, and this has taken place more rapidly of late years, so that a very careful inspection is necessary in order to separate the beds from each other.

The moa findings are mainly on the high almost inaccessible ridges of limestones, in very broken country or in caves, except in the case of deposits on shelving coast areas where sand occupies the site of land that has been worn down to the level or below the level of the surrounding sea. An examination of the coastal beds shows that fresh-water shells are associated with the bird-bone beds, and that the bones represent birds that have disappeared or are disappearing to-day.

Between Wainui (south of Cape Turnagain) and the East Cape the sands provide no evidence of contemporaneity between the moa period and the Maori period, and certainly one could not gather that the Maoris ate the eggs of the moa because broken shells are common among the bird-bone sand-deposits. Frequent visits to the deposits along the coast have convinced me that the moa period coincided with the deposition of the lowest sands, which go back a long series of years. The extensive sand-deposits south of Turnagain, at Waimarama (south of Cape Kidnappers), at Nuhaka (on the north shore of Hawke's Bay), at Wainui (east from Gisborne), and at Pakarae (near Whangara, to the north of Wainui) contain numerous bones of the adult and chick moas, together with broken shells, but there is no

trace of a moa having been cooked in a Native *hangi* or of being disturbed by a horde of hungry hunters. For miles along the coast near Wainui South moa-bones and broken pieces of egg-shells are common. I have seen entire skeletons exposed following long-continued easterly winds, and lying as if the birds had died on the spot or had been carried to the place by means of water, to be subsequently covered and buried in the sands. In the vicinity hundreds of Maoris have lived for centuries, judging by their extensive middens, and it is inconceivable that the complete bodies of moas should have been left untouched within a short distance of a Native village when animal food was so scarce among them.

At Waimarama, as related by Mr. A. Hamilton, F.G.S.,* we saw a place where a big storm had washed out half an acre or more of the upper sand-beds, and had left exposed many thousands of bones in the lower beds, but too fragile for removal. They were arranged as by an artist. Had the birds to which the bones once belonged been killed and cooked by the Maoris the bones could never have lain as we saw them, and had there been dogs it is hardly likely that such an abundance of bones would have remained in perfect condition and spread about in regular order.

The moa-footprints at Gisborne, near the mouth of the Waikanae, suggest that the birds were either seeking for food in the vicinity or that it was a crossing-place to the birds' resorts a few miles farther on. It appears as if the coast sands were occupied as breeding-grounds, and nothing more.

Near Pakarae, where extensive sand-dunes exist, I found some years ago a depression in the lower sands that had been exposed after a succession of bad weather and fierce winds, and it contained the broken remains of the greater part of a moa-shell cemented together in a way that suggested it had been broken by pressure—the inner surface held together by the yolk material.

Indeed, everything along the coast where moa-remains occur suggests that the sands were frequented for breeding purposes only. I am not prepared to say the same of all the other birds whose bones are found along with those of the moa. Thinner and different kinds of broken egg-shells are to be found, but there are no traces that the birds when living were disturbed by man. As far as I can discover after working again and again the sands along the East Coast where Maoris have dwelt for many generations—and middens are numerous—there is no evidence to show that the moa was ever hunted by the Maori for food, that eggs were cooked and eaten, or that bones were ever broken for the extraction of marrow for food of dogs.

It has already been remarked as to the great length of time represented by the lower deposits of certain coast sand-deposits. They correspond to the age of high-level shingle conglomerate that preceded the plains, like those of Heretaunga, Ruataniwha, Wairarapa, Wairoa, and Poverty Bay. These alluvial plains are of comparatively recent make, and to gain a true conception of the days of the moa and the surface features of the country when the bird flourished and roamed over it the surface features as represented by its remains must be carefully studied. The moa could not live or breed on or within an area which was subjected to constant change. Its home was among the downs, the rough limestone hills, and solitary uplands, where food was plentiful and enemies few. The localities enume-

* Trans. N.Z. Inst., vol. 21, p. 313.

rated show that moa-remains are found from sea-level to an elevation among the mountains exceeding 3,000 ft., and throughout an extensive district containing rocks representing various geological periods. The localities are classed under the following periods: (1.) Lowest coast sands, corresponding to the high-level gravels or oldest Pleistocene, containing bone, egg-shells, and chicks. (2.) Footprints and fossil feathers, corresponding to high-level gravels and lowest sand-deposits. (3.) Swamps, Te Aute: abundance of bones: period, Pleistocene, corresponding to moa feather and footprint period. (4.) On Pliocene country: Havelock, Maraekakaho, Napier, Pohui, Puketitiri, and Petane. (5.) Miocene country: Anaroa, Makotuku, left bank of Manawatu, Ngapaeruru, Wimbledon, Mohaka, and Waikare. (6.) Secondary rocks: Tarawera, Matawai, Motu country. (7.) In caves among Tertiary rocks: Upper Hangaroa, Waikaremoana, Marumaru, Pohui, Mangatu, Mangaone, Mount Hikurangi, Mangatoro Valley. (8.) In high-level shingle conglomerates, at the south end of the Whakapunake Range.

The distribution of bones and complete skeletons, some in caves and others in the open country, suffices to indicate that in general the surface features of the land have not altered to any large extent since the times of the moa. The great plain formations and river-basins have changed considerably, but the general features of the country, except the forest area, have undergone no distinctive change other than in the formation of new river-basins and the growth of plains like those of Heretaunga, Poverty Bay, Ruataniwha, and Wairoa. Thus it is certain that—(*a*) the moa was living previous to the plain deposits such as now exist; (*b*) it was living in Pleistocene times; (*c*) it roamed over the hill country through a district extending for 350 miles, and at elevations from sea-level to 3,000 ft. or more; (*d*) although moa-bones are found in numerous caves of different ages, there is no evidence that the caves were used for shelter at intervals; (*e*) it lived at a time when conditions existed for the accumulation of many bird-skeletons within a single water area or swamp.

Had there been human beings or native dogs in the country during the moa period it is difficult to understand the large bone-accumulations such as are met with in swamps, in caves, and other areas, and it is more difficult to understand why moas under ordinary conditions should have congregated in caves and have died there.

In the Hangaroa district, near to the place traversed by the Rev. William Colenso in 1841–42, a cave was lately discovered and explored by me containing several perfect skeletons of the moa. The entrance had been long closed by a deposit of pumice sand when first visited. All the appearances suggested that the birds had sought the cave for shelter and safety from some danger that beset them, and that the entrance had been closed by the loose pumice sands sliding from overlying rocks, leaving the birds to die a lingering death. Since Colenso's visit many bones of the moa have been found within the Hangaroa River basin, in which the celebrated peak called Whakapunake is situated. The country has scores of rock shelters and potholes leading to underground caves, which are numerous, and no doubt many great finds of moa-bones will be made as the country becomes more settled.

At Pohui, on the Napier–Taupo Road, many specimens of the moa have been found among the large limestone rock-masses and caves that occur along the east valley and deep gorges at the foot of the Te Waka Range.

The distribution of the bones of moas throughout so large an extent of country in horizontal and vertical space shows conclusively, it appears to me, that the birds had few or no enemies to limit their existence, their movements, or their multiplication. At Lake Waikaremoana, and at Matawai, in the Motu country, the *Dinornis maximus* appears to have predominated. Enormous pelves and leg-bones and whole strings of tracheal rings and vertebral bones have been collected in a number of places, and doubtless the time will come, as the country is settled, when many specimens of the moa will be found in this bold rugged country, where caves, potholes, and rock shelters are common. In the Marumaru caves, beyond Wairoa, the bones are also very large ; but the largest pelves I have seen were from the Matawai caves, which certainly existed before the country was forest-clad. The absence of skulls in several cases is to be regretted, but it appears to arise from the lack of knowledge in the case of those who first enter the caves. Usually the discoverers do not appreciate a find unless there are great leg-bones. The mandibles, sternum, vertebral bones, and foot-bones are considered as being of no use, and on one occasion I discovered a pelvis had been taken for the skull of a bullock by a roadman, who found a particularly fine specimen of the skeleton of a moa among some great rock-masses near Waikaremoana Lake.

In the hill-range leading to Mount Hikurangi—the mountain referred to by Polack—a settler discovered a number of moa-skeletons a short time ago. Thus Mr. Allen Watkins, of Tokomaru Bay, to whom I am indebted for the information, writes,—

> The moas—five in number—were in a rock about 8 ft. by 8 ft., and were all lying with their heads together on a ledge at the extreme end of the cave.
>
> Very few of the bones were missing, and, the heads being in an excellent state of preservation, my brother mounted the biggest of the birds, and it stands about 5 ft. high—a little over, if anything. Horihori Station, where the birds were found, is twenty miles from the sea, and of extremely rocky formation, and where the cave is must be quite 2,000 ft. up. The surrounding timber was exceptionally heavy, including all the well-known larger forest-trees—rimu, miro, pukatea, rata, &c. Distance from Hikurangi, five miles.
>
> The position of the birds leads me to think they were fleeing from some enemy, or perhaps fire, otherwise why the heads all together on a little ledge with the bodies out in the cave—a peculiarity of this species when escaping from danger ?

This description agrees generally with what appeared in the Hangaroa caves.

All the caves that have come under my notice as containing moa-bones are at a fairly high elevation, and are usually found in the midst of a bush area. The position of skeletons in the caves as seen by me suggests that the birds had sought refuge from fear. The caves in no single instance showed traces of frequent use as a resort, and the only suggestion is that the birds hurried from open country or from the hills in the vicinity to shelter themselves or protect themselves from some sudden danger. Everywhere there are traces of a heavy pumice-sand deposit, and the surrounding rocks are usually broken and greatly disturbed, as if great earth-movements had taken place. Scattered bones and bone-heaps are found in some of the highest and roughest country, as if the birds had been hurrying from the lowlands in search of shelter. Death had met them by the way, and there had been no enemy—either man or animal—to interfere with flesh or bones. In some places heaps of smooth small whitish stones are found where great bush-fires have occurred and burnt all that was capable of burning of moa-remains.

In the case of deposits of moa-bones in swamp areas that were obtained at Te Aute, and described by the late Mr. A. Hamilton, F.G.S., Director of the Dominion Museum,* it is necessary to understand the character of the country in the vicinity. The long north-east–south-west valley extending from Waipukurau to Pakipaki runs between two ranges of hills, the range on the right (in the direction of Hastings) being made up of older Pliocene and Miocene beds, and that on the left of Miocene and Cretaceo-tertiary marls. These separate ranges were once a part of the same series, but during the times of volcanic activity which closed the Pleistocene period there was a violent uplift along the present valley, followed by a subsidence, and the lake and lakelets are the remains of the changes that then took place. Since then the Heretaunga Plain has been rebuilt, the rivers Tukituki and Waipawa have made a course along a subsiding fracture from Waipukurau, by way of Patangata, and down the valley behind Havelock, into the Heretaunga Plain. All the hill country in the vicinity of the ranges named appears to have been inhabited by numerous moas at the time of the volcanic period, when earthquakes were common and surface changes frequent. The moas were either suddenly destroyed at this time or disappeared from the East Coast district. They were not destroyed by man or any natural enemy, as otherwise their bones could never have accumulated without injury in an area of limited extent and of a particular type. The abundance of bones uninjured and undisturbed shows that the animals must have died suddenly, and were uninjured by man or beast. Further, they were either drowned or destroyed in some way where their bodies were found, or in close proximity. Subsequently their bodies were washed from the hill country into the depressed area by great floods following the volcanic and earthquake disturbances. Thus the moa-bone accumulations in the Te Aute Swamp, as described by Mr. Hamilton, might easily have been brought down from the surrounding hills by heavy floods following a period of great volcanic activity and earth-movements, when vegetation was destroyed either by falling ashes or by poisonous exhalations from the ground such as were experienced at St. Pierre in the West Indies and at Messina in Sicily in times of intense earth-movements.

Mr. Hamilton, in his interesting account,† offers the hypothesis that the spot where the vast accumulations of bones were obtained "was a narrow crossing-place in a swampy forest"; but the discovery of other bones in a spot nearly two miles from the original find, and at the foot of a spur, leads to the conclusion that the birds were fleeing when overtaken by some sudden catastrophe.

The section exposed in the Te Aute Swamp, where Mr. Hamilton made his first find of moa-bones, was in "the cutting of a drain about 15 ft. deep, of which from 8 ft. to 10 ft. was of silt deposit (pumice and washings from the Cretaceous rocks of the district)." These facts all go to suggest volcanic and earthquake disturbances when the moas were living; but the fact that the moa-bones are found associated with *Cnemiornis* (a great extinct goose), with *Harpagornis* (a great extinct eagle), and with *Notornis* (the gigantic rail), as Mr. Hamilton points out, provides additional support to the theory that all these birds were destroyed suddenly when assembled together in the vicinity of the rifts where their bones are found.

And does not the legendary history of the Maori along the East Coast offer a suggestion and an interpretation to the geologist who studies the

* Trans. N.Z. Inst., vol. 21, p. 311.
† Trans. N.Z. Inst., vol. 21, p. 316.

surface features of the country? The sending of hot embers by Rangi in answer to the prayer of Tamatea suggests disturbances and destruction by fire. Along the East Coast and inland, as I have elsewhere indicated,* pumice sands are to be seen varying in thickness from a few inches to many feet, constantly thickening as they are followed to the volcanic area.

The falling of hot pumice and scoria might cause the destruction of most of the vegetation in the country throughout the Island, just as the mud, sands, and pumice did in the vicinity of the Tarawera eruption in the year 1886.

If accompanied by gaseous exhalations from earthquake-rifts such as were common during the later Pliocene and Pleistocene periods, all difficulties vanish in supplying reasonable explanation for the sudden disappearance of the moa, and why skeletons are found in caves and in the open so perfect and complete.

The fossil feather-markings are described in vol. 21 of the Transactions, page 318, from the Ormond pumice-mud deposits, and the footprints of the moa from the several localities show that the pumice was loose and soft when the impressions were made. Associated with these beds are others at Whautaupoko, Ormond, and the Kidnappers, which contain perfect leaf-impressions, representing a great variety of trees and ferns and Lycopods, with numerous fish vertebrates and the fossil feathers. Had man existed at the time, why is there no trace in the shape of footprints, broken bones, stone implements, or other forms of human industry?

The history of the East Coast is complete as a geological sequence, and the sudden disappearance of birds over a wide extent of country under varying conditions of living requires an explanation that carries conviction and is supported by geological evidence. That evidence is forthcoming in the wide distribution of pumice, in the traces of earthquake-rifts, and in the absolute knowledge that volcanic activity was particularly active during a portion of the Pleistocene period. At that time the moas were numerous in the land; they had become widely differentiated; they were found occupying Tertiary and Secondary land-surfaces, and were constant visitors along the East Coast to the warm sands, where breeding appears to have been carried on. They range in vertical space to a height exceeding 3,000 ft. The association of bones of the moa with others whose habits were altogether dissimilar must be explained in a way likely to carry conviction. Native legend tells us of the destruction by fire of the moa. It makes no reference to other birds. Tamatea was the reputed son of Rongokako, to whom reference has already been made with respect to footprints.

These legendary heroes the Maoris dwell upon with pride in relating their ancestry. In times long past the tradition had been received of very large birds having once existed; but they knew nothing as to the kind of bird, and so crude were their ideas on the subject that Polack, Colenso, Taylor, and others could obtain no single fact on the subject.

Does not this suffice to show the utter ignorance among the Natives concerning the bird that was called "moa," "movie," and so on? The Natives from whom Polack first obtained his legend had never seen the bird as described by them. They were unaware of its having dwelt on the coast sands: they stated it lived at Ikorangi, a mountain far in the interior, in one instance; at Whakapunake, in another instance; and Colenso was

* Trans. N.Z. Inst., vol. 20, p. 293.

told the moa was in the Te Wai-iti Mountains, whilst White, in his "Ancient History of the Maori," says the last moa was killed at Wai-pukurau! All these tales suffice to show the uselessness of describing the moa as having disappeared during the last century. The middens suffice to the contrary. The swamp areas show a long period of slow growth that must be counted by centuries, and the caves wherein so many complete skeletons of moas have been found suggest that they were sealed by pumice or other volcanic material centuries ago.

From these remarks it will be noticed that the East Coast district provides no evidence in support of those who contend that the moa has only recently disappeared from the country, and this by the hands of Maori hunters. In vol. 24, page 169, of the Transactions the late Professor Hutton concludes his able paper "On the Moas of New Zealand" thus: "In the North Island we have at Wanganui and near Whangarei undoubted proofs that the ancestors of the present Maoris killed and ate moas . . . and we must conclude that the moa was exterminated not long after their arrival in New Zealand." In vol. 15 there is a paper on "Moa and Moa-hunters," by A. de Quatrefages, translated from the French by Laura Buller, and it concludes as follows: "It is therefore clear that, far from being too bold, I had underestimated the time of the disappearance of the moa in carrying it back so far as the end of the last century."

On the other hand, the late Sir Julius von Haast (vol. 4, p. 91) gave it as his opinion that "the moa owed its destruction to a different race and period to the Maori race in New Zealand"; whilst the Revs. William Colenso, F.R.S., and James Stack, Major Mair, Colonel Porter, and many others affirm that the moa was a traditional something—bird, or man, or atua—in the early days, when the bones found on the banks and in the beds of rivers began to be sought after by the early missionaries and settlers. The geological facts brought forward by me dealing solely with the East Coast throws back still further the time when the moa disappeared.

The history of the moa is the history of a race of birds that disappeared long anterior to the coming of the Maoris to New Zealand. It belongs to the later Pleistocene period rather than the Recent—to the period of intense volcanic activity, the period of great earth-movements and earth-breaks, when birds that flew congregated with birds that ran, birds herbivorous with birds carnivorous, in their efforts to escape from the destructive effects of dust and ashes and poisonous vapours that were spread broadcast over the land, and from the great floods that followed in their wake. The birds, in their efforts to escape, made for the uplands, some seeking shelter in caves, some amidst the fallen and broken rock, and some reaching the open lands and the topmost hills. All died suddenly; nor was there an enemy left, man or beast, that could use the flesh or bones of the thousands of dead birds that were destroyed. Those that sought shelter in the caves died like those in the open, and each entrance to them was sealed by the falling pumice or loose debris near by. Those on the hills were washed down into the newly formed earth-breaks with pumice and dust to testify as to their mode of destruction and their mode of preservation. The history of the moa is the history of a long past. It reaches back to the legendary history of the Maori race, to the time when the South Island was peopled by giants who could stride from mountain-range to mountain-range, could swallow up rivers, and transform themselves into animate or inanimate nature, as told in White's "History of the Maori," vol. 3, p. 191. The history of settlement in the North Island has the same legendary basis, and the moa

was just as legendary among the Maoris of this Island as was, and is, the story of those wonderful men like Rongokako, Tamatea, and Rangi, and scores of others, who were able to perform such wonders and exploits, according to Maori tradition.

The following table gives particulars of moa-remains found in New Zealand :—

Places and Locality.	What found.	Remarks.
1. Wainui–Herbertville	Full skeleton, many bones, shells	Sandhills south of Herbertville, Cape Turnagain. Would repay further search. D. Munro and H. H.
2. Wimbledon ..	Many bones, imperfect skeleton..	Taylor White and others.
3. Ormondville ..	Odd bones, mostly leg-bones ..	In caves near river. H. H.
4. Paroa–Ngapaeruru	Skeleton, top of limestone hill, 2,000 ft., dense bush.	Have seen bones. H. H. Messrs. Holden and Fletcher.
5. Mangatoro Valley..	Three skeletons (nearly complete) in cave, 1,400 ft. above sea-level	Mr. John Wright, Coonoor, Mangatoro Valley.
6. Palmerston North..	Moa-footprints	Mr. Gilberd, H. H. (Trans. N.Z. Inst., vol. 27, p. 476.)
7. Waimaramara beach sands	Half an acre of bones	A. Hamilton, H. H. (Trans. N.Z. Inst., vol. 21, p. 313.)
8. Otane	Well-sinking at school, 18 ft.; tarsal bone	Mr. Garry, at school. Young bird.
9. Te Aute Swamp ..	Many skeletons; innumerable bones; excellent preservation. Many other birds	See Hamilton's paper (vol. 21). Have visited the locality and collected specimens. Mr. Williams, Te Aute, possesses large bone specimens. Napier Athenaeum specimens. Mrs. Ellison and H. H.
10. Anaroa	In Mason's caves, north-west Te Aute	Have obtained several specimens. H. H.
11. Havelock North ..	Skeleton of moa, 800 ft. ..	Colenso (vol. 12).
12. Kaokaoroa Valley, in Havelock district	,, ,, ..	Mr. Joseph Price.
13. Maraekakaho ..	Tibia, 30 in. long	Mr. Lockie, Maraekakaho Station; 1912.
14. Napier	Footprints, Reservoir, Lighthouse Road	Mr. R. Lamb, H. H.; 1887.
15. ,, ...	Many bones, near Drill-shed ..	A. Hamilton and H. H.; 1886.
16. ,, ...	Shakespeare Road, several bones	Mr. Errol, F. W. Williams, and H. H.; 1912.
17. Petane	Egg-shells and bones	F. W. Williams, A. Hamilton, and H. H.; 1884–90.
18. Pohue	Several skeletons, humeri, pelves, &c.	Mr. Crawford, Mr. King, and H. H.; 1890 and onward.
19. Tarawera (50 miles north-west of Napier)	Several leg-bones, tibia, femora; 2,000 ft. above sea-level	Mr. Cropp, Postmaster. Have examined these. Were washed from hilltop during a heavy flood.
20. Pakipaki ..	Numerous bones in road-cuttings	A. Hamilton and H. H.; 1890.
21. Hawkestone, near Puketitiri	Numerous bones, skull, sternum..	T. Hallett, H. H.
22. Waihua, Mohaka ..	Tibia-bones and other bones exposed in cutting on roadside	Mr. Guthrie-Smith. Sent to Wellington.
23. Mohaka, on Wairoa Road	Numerous large bones exposed after blasting on roadside	Bishop Williams, Albert te Kati; 1886.
24. Marumaru caves ..	Many bones, skulls	Mr. Beckett and H. H.; 1906–8.
25. Te Reinga (shingle conglomerate)	Fossil femora in conglomerate, 900 ft. above sea-level and 50 ft. in conglomerate	J. Ramlose, H. H.; 1912.

Places and Locality.	What found.	Remarks.
26. Waikaremoana ..	Numerous skeletons, reserves of hills and dry bush	J. Goodall, Rosie Bay; 1912. A. Adams, J. McGrath; one mile from accommodation-house.
27. Nuhaka	Skeletons, many bones, shells; sea-beach	A. and H. Hamilton, H. H.; 1910.
28. Mangaone Valley, near Nuhaka	Shells, skeletons, &c.; in caves 500 ft. above sea. Old and young bird bones	H. Hamilton and H. H.; 1906–12.
29. Opoutama, Te Mahia	Bones, shells	H. H.; 1910.
30. Gisborne.. ..	Fossil footprints, bones; numerous since 1839	Bishop Williams, sen.; 1878. H. H.; 1879. Bones since 1839 onward.
31. ,, ...	Many bones at Tua, Muto swamp, near island	H. H.; 1880.
32. Wainui beach ..	Many bones, egg-shells; on beach, lower sands	Many persons have collected specimens for years.
33. Ormond	Shells fossilized and bones in railway cutting and river-bank	Mr. Chambers and H. H.
34. Pakarae	Shells, bones; next depression ..	H. H. Collected for a number of years.
35. Hikurangi Mountain	Number of moa-skeletons, caves, lower range, 3,000 ft.; numerous bones in Waiapu River	Mr. Watkins; 1912.
36. Waiapu, East Cape, near mouth of river	Bones first obtained in 1839 ..	See map.
37. Matawai, Motu ..	Caves in hills, 3,000–3,300 ft.; numerous bones. More exploration desirable	Mr. McKenzie and H. H.; 1912–13.

The map I have prepared (p. 331) shows the different places where traces of the moa are personally known by me, and as stated in the accompanying tabulation. There may be others with which I am not acquainted, but this can be entered later. Similar maps might be prepared for other districts by those who are interested in the subject, and similar inquiries pursued with a view to arriving at a correct knowledge of the life-history of the moa.

The map also shows—(*a*) Polack's locality for trade, 1834–37; (*b*) Rev. William Williams's visit to Te Mahia, 1834; (*c*) journey of Rev. William Williams and Rev. W. Colenso, 1838–39; (*d*) journey of Rev. William Williams and Rev. Mr. Taylor, 1839; (*e*) journey of Rev. William Colenso, 1841–42.

PROCEEDINGS.

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE.

1913.

ELEVENTH ANNUAL MEETING.

WELLINGTON, FRIDAY, 30TH JANUARY, 1914.

THE annual meeting of the Board of Governors of the New Zealand Institute was held in the Parliamentary Buildings on Friday, the 30th January, 1914, at 10.30 a.m.

Present: Professor Charles Chilton, President (in the chair), Dr. L. Cockayne, F.R.S., Mr. C. A. Ewen, Professor Easterfield, Professor C. C. Farr, Dr. Hatherly, Mr. H. Hill, Professor Kirk, Professor Marshall, Mr. D. Petrie, Mr. R. Speight, Mr. J. Stewart, Mr. G. M. Thomson, M.P., Dr. J. Allan Thomson, Professor von Zedlitz, and Mr. K. Wilson.

Changes in the Representation.—The Secretary announced the changes in the representation—viz., Professor von Zedlitz replacing Mr. Young and Dr. Thomson the late Mr. Hamilton as the Government nominees; Professor Easterfield, as representative of the Wellington Philosophical Society, replacing Mr. Martin Chapman; and Dr. Hatherly, representative of the Wanganui Philosophical Society, replacing Mr. Hesse.

Roll.—The Secretary then called the roll.

Apologies for Non-attendance.—Apologies were received from the Hon. H. D. Bell, K.C., Minister of Internal Affairs, and from Mr. A. H. Turnbull.

The late Mr. A. Hamilton.—The following resolution was, on the motion of the President, seconded by Mr. G. M. Thomson, unanimously carried: The Board of Governors of the New Zealand Institute desires to place on record its sense of the loss sustained by the cause of science through the death of the late Augustus Hamilton, for ten years Director of the Dominion Museum, and a valued member of this Board from the date of its formation. Mr. Hamilton was interested in many branches of scientific research, but it

is by his monumental work on Maori art that his name will be best remembered. His courtesy and kindly disposition, his readiness to assist all who were desirous of acquiring information, and his enthusiasm in the advancement of scientific research and progress caused him to be universally esteemed and respected. The Board desires to convey to Mrs. Hamilton and her family its deep and sincere sympathy in their bereavement.

Presidential Address.—The President then read his annual address. (See page 363.)

Incorporated Societies' Reports.—The annual reports of the incorporated societies as enumerated in the Standing Committee's report were laid upon the table.

Standing Committee's Report.—The following report of the Standing Committee for the year ending 31st December, 1913, was received:—

STANDING COMMITTEE ANNUAL REPORT FOR THE YEAR ENDING 31ST DECEMBER, 1913.

Four meetings of the Standing Committee have been held during the past year, the attendance being as follows: Mr. Chapman, 1; Mr. Cheeseman, 1; Dr. Chilton, 3; Dr. Cockayne, 1; Mr. Ewen, 3; Mr. Hamilton, 3; Mr. Hesse, 2; Professor Kirk, 3; Mr. Petrie, 2; Mr. Stewart, 1; Mr. Thomson, 2; Mr. Turnbull, 2; Mr. Wilson, 2; Mr. Young, 1.

Hector Memorial Award.—The presentation of the medal to Professor Easterfield, the recipient for the year 1913, took place at the Town Hall, Wellington, on the 9th July, 1913. His Excellency the Governor, Lord Liverpool, made the presentation.

Award for 1914.—The Committee of Award—Mr. T. F. Cheeseman, Mr. Etheridge, and Professor Baldwin Spencer—have made a recommendation which will be considered at the annual meeting.

Deed of Trust.—The possibility of altering the Hector Deed of Trust in order to conform to the conditions laid down by the Hector Memorial Committee has been under consideration by the Board's solicitors, and legal opinion will be submitted for consideration at the annual meeting.

Hutton Memorial Fund.—Two applications for grants have been received, and are submitted for consideration of the Board. Professors Benham (Dunedin) and David (Sydney), with Mr. Maiden (Sydney), have made a recommendation of a recipient for the award in 1914.

Publications of the Institute.—Copies of vol. 45 of the Transactions were laid on the table of the House of Representatives on the 3rd July, 1913, and on the table of the Legislative Council on the 27th June, 1913. In accordance with a resolution of the Board, the separate publication of the Proceedings has ceased.

Bulletin No. 3, "Studies in the Bryology of New Zealand," by Mr. H. N. Dixon, was published on the 30th June, 1913. A number of copies have been distributed gratis to periodicals for review purposes in accordance with a list of botanical magazines kindly supplied by Dr. L. Cockayne, F.R.S.

Finances of the Institute.—Mr. G. M. Thomson reported that, in conjunction with Dr. A. K. Newman, M.P., Mr. A. M. Myers, M.P., and Mr. H. G. Ell, M.P., he had brought the question of the financial needs of the Institute before the Hon. H. D. Bell, Minister of Internal Affairs. While the Minister was not prepared to recommend the Government to amend the New Zealand Institute Act in the direction of altering the statutory grant from £500 to £750, he had secured a special grant of £250 for the current year.

Fishes of New Zealand.—The desirability of having a catalogue of the fishes of New Zealand prepared was again brought before the notice of the Minister of Marine by Mr. G. M. Thomson, but in view of the projected examination of the fishery resources of the Dominion by Professor Prince, of Canada, the Government are not prepared to take any immediate action in the desired direction.

British Association Reception Committee.—This Committee, on which the Institute is well represented, is making arrangements for receiving in New Zealand after the close of the Sydney meeting a certain number of the official members of the British Association at the Australian meeting. It is anticipated that meetings will be held in Wellington and Christchurch. Fifteen American and Canadian scientists will be invited

to meet the British visitors. The New Zealand Government has continued the offer of its predecessors in office, and is represented on the Committee by Mr. James Hislop, Under-Secretary of the Department of Internal Affairs. A pamphlet setting forth the attractions which New Zealand offers to the man of science has been prepared, and is now in the press.

Decisions of the Standing Committee.—The only resolution which calls for record passed by the Standing Committee during the year was that the amount of the Hector Award for 1913 should be £40.

Annual Reports of Societies.—The annual reports and balance-sheets of the following societies have been received: Auckland Institute, to 19th February, 1913; Hawke's Bay Philosophical Institute, to 12th December, 1913; Manawatu Philosophical Society, to 31st October, 1913; Wellington Philosophical Society, to 24th October, 1913; Canterbury Philosophical Institute, to 31st October, 1913; Otago Institute, to 28th November, 1913.

Southland and Westland Societies.—In accordance with the resolution of the Board of Governors, the names of these societies ceased to appear as incorporated societies one month after the last annual meeting, held on the 29th January, 1913.

Special General Meeting to consider the Science and Art Bill.—A special meeting of the Board was held in Wellington on the 5th September, 1913. Present: Professor Charles Chilton, President (in the chair), Hon. H. D. Bell, K.C. (Minister of Internal Affairs), Mr. M. Chapman, K.C., Mr. C. A. Ewen, Professor C. C. Farr, Mr. A. Hamilton, Mr. H. W. Hesse, Professor H. B. Kirk, Mr. D. Petrie, Mr. James Stewart, C.E., Mr. G. M. Thomson, M.P., Mr. A. H. Turnbull, and Mr. John Young.

The President detailed the reasons for calling the Board together, which was to discuss the Science and Art Bill before Parliament. He read the resolutions passed by the Otago Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, and the Auckland Institute, objecting to the passing of the Bill in its present form.

The Minister of Internal Affairs (Hon. H. D. Bell) explained the intentions of the Government with regard to the Institute as affected by the Bill.

The Minister's proposal and the Bill was then fully discussed in committee, and on the motion of Professor Kirk, seconded by Mr. Petrie, it was resolved, on the casting-vote of the Chairman, That the Institute cannot agree to the proposal that the issue of its Transactions and Proceedings should come under review of an outside Board.

On the motion of Mr. Stewart, seconded by Mr. A. Hamilton, it was resolved, That in the fixing of the constitution of the Board of Science and Art the representation of the New Zealand Institute should be increased to four members.

On resuming, it was resolved to adopt the motions passed in committee.

On the motion of Mr. Young, seconded by Mr. Chapman, it was resolved that the President should attend the Committee of the Houses of Parliament to which the Bill was referred, and give evidence on behalf of the Institute.

It was left with the President and Mr. Hamilton to confirm the minutes.

Scientific Board of Advice.—Mr. G. M. Thomson, M.P., reports as follows: In furtherance of the recommendations made during the session of 1912 by the Museum and Scientific Departments Parliamentary Committee, the Government introduced a Science and Art Bill into the House of Representatives on the 27th August, which was referred to a Select Committee for report. Under this Bill it was proposed to set up a Board to control the Dominion Museum, a Dominion Art Gallery, and a Dominion Scientific Library, as well as the scientific publications of the Government and of the New Zealand Institute. The composition and powers of this Board were not acceptable to the executive of the Institute, and evidence to that effect was given before the Committee by your President, Professor Charles Chilton, with the result that the connection of the Institute with the proposed Board was severed, only that the President of the New Zealand Institute becomes *ex officio* a member of the Board.

On the motion of Mr. Hill, seconded by Mr. Stewart, it was resolved, That the thanks of the Governors be accorded to Mr. G. M. Thomson, M.P., and the gentlemen who accompanied him to interview the Hon. H. D. Bell.

Finance.—Balance-sheet, assets and liabilities statement, and the balance-sheets of the Carter Bequest, the Hutton Memorial, and the Hector Memorial Funds, duly audited by the Auditor-General, were adopted, as follows:—

STATEMENT OF RECEIPTS AND EXPENDITURE for the Year ending 31st December, 1913.

Receipts.	£	s.	d.
Balance at credit in Bank of New Zealand	151	1	5
Government grant to 31st March, 1914	500	0	0
Supplementary Government grant	250	0	0
Sale of Transactions and Index	35	2	0
,, "Maori Art" ..	9	2	10
,, authors' reprints ..	1	13	6
,, 3,000 envelopes ..	2	8	0
	£949	7	9

Expenditure.	£	s.	d.
Travelling-expenses ..	58	8	2
Fire-insurance premium, library, £1,500	5	0	0
Secretary's salary	30	0	0
Museum custodian's services	5	0	0
Compiling catalogue scientific literature	10	0	0
Bank charge	0	10	0
Covers for posting Transactions	5	12	6
Postage on Transactions ..	18	19	0
Miss Wilson, typing ..	5	0	0
West, Newman, and Co., four blocks, mosses	4	3	6
Customs duty on four blocks, Dixon's bulletin ..	1	2	0
Sir Joseph Hooker Memorial	1	1	0
Government Printer, vols. 44 and 45	345	17	6
Petty cash—			
Hon. Editor	3	0	0
Secretary	3	0	0
	496	13	8
Balance in Bank of New Zealand	452	14	1
	£949	7	9

STATEMENT OF LIABILITIES AND ASSETS at 31st December, 1913.

Liabilities.	£	s.	d.
Dec. 31. Balance due Government Printer, vol. 45 ..	283	10	0
Credit balance	191	10	7
	£475	0	7

Assets.	£	s.	d.
Balance in Bank of New Zealand	452	14	1
Refund of Customs duty ..	1	2	0
Wesley and Son, Transactions sold	13	7	8
Authors' reprints	3	6	4
"Maori Art" sold to Braithwaite	4	10	6
	£475	0	7

In addition to the above assets, the Institute has a large stock of Transactions for sale and a very valuable library.

CARTER BEQUEST.—Statement of Accounts, 31st December, 1912, to 31st December, 1913.

Cr.	£	s.	d.
Balance at 31st December, 1912	3,264	8	7
Debentures, N.Z. Loan and Mercantile Agency Company	0	5	0
Interest, N.Z. Loan and Mercantile Agency Company	0	14	5
Dividend, N.Z. Loan and Mercantile Agency Company	0	1	8
Interest, Public Trust Office	145	11	7
	£3,411	1	3

Dr.	£	s.	d.
Public Trust Office commission	0	0	7
Balance	3,411	0	8
	£3,411	1	3

HECTOR MEMORIAL FUND.—Statement of Accounts, 31st December, 1912, to 31st December, 1913.

Cr.	£	s.	d.	*Dr.*	£	s.	d.
Balance as at 31st December, 1912	1,030	15	1	Balance	1,077	7	3
Interest, Public Trust Office	46	12	2				
	£1,077	7	3		£1,077	7	3

HUTTON MEMORIAL RESEARCH FUND.—Statement of Accounts, 31st December, 1912, to 31st December, 1913.

Cr.	£	s.	d.	*Dr.*	£	s.	d.
Balance as at 31st December, 1912	690	4	10	Balance	721	5	5
Interest, Public Trust Office	31	0	7				
	£721	5	5		£721	5	5

It was proposed by Mr. D. Petrie, seconded by Dr. L. Cockayne, That the Board of Governors press on the Government the need of increasing the statutory grant in aid of the New Zealand Institute from £500 to £1,000 a year.—Carried.

The following motion was proposed by Mr. Hill, and, after discussion, was withdrawn : "That the Government be recommended to set aside an area of land as an endowment to the New Zealand Institute Board of Governors to enable them to obtain a sufficient income to foster original research in natural and physical science in a way deemed necessary by the Governors."

On the motion of Mr. C. A. Ewen, seconded by Dr. Cockayne, it was proposed, That, in terms of Regulation No. 5, section (*e*), the Institute, on and after this date, will require from each of the incorporated societies a contribution of 2s. 6d. per member. Professor Marshall moved the following amendment, which was seconded by Dr. Hatherly : That the question raised in the motion be referred to the different Institutes for consideration and report. The amendment was carried by nine votes to five.

British Association Reception Committee.—Dr. Thomson announced that the Minister desired that he should take the late Mr. Hamilton's place on the Committee.

Charge for Authors' Reprints.—On the motion of Mr. Speight, seconded by Mr. Ewen, it was resolved, That the affiliated societies be asked to collect the amounts due for authors' reprints, and forward the same to the Secretary of the New Zealand Institute.

Hutton Memorial Award.—The report of the Award Committee was received in a sealed envelope. The President announced that the Committee recommended the name of Dr. Leonard Cockayne, F.R.S., who has done admirable work on the ecology of New Zealand plants, for the medal for the present year. The recommendation of the Committee was unanimously adopted. The President congratulated Dr. Cockayne, who suitably responded.

Hutton Fund Research Grants.—Application for grants from the fund were received from Major Broun, on behalf of Mr. T. Hall, for a grant of £20 for collecting entomological and other specimens of the New Zealand

fauna for Dr. Chilton and for Major Broun ; and from Dr. Hilgendorf for a grant of £10 for apparatus required for researches on artesian wells in Canterbury. On the motion of Professor Easterfield, seconded by Mr. G. M. Thomson, M.P., the applications were granted.

Hutton Memorial. — On the motion of Mr. Speight, seconded by Dr. Cockayne, it was resolved, That grants from the Hutton Memorial Fund may be made to approved individuals for some specified research, and that a committee be set up, consisting of Professors Chilton and Marshall and Dr. Cockayne, to make suggestions to this Board, and that such suggestions be considered when applications for grants are being considered by the Board.

On the motion of Professor Easterfield, seconded by Mr. G. M. Thomson, it was further resolved, That the Institute draw the attention of the local societies to the existence of the Hutton Research Fund, and request that the attention of the members of the local branches be directed to the conditions.

Hector Memorial Fund.—The legal opinion of Mr. C. P. Skerrett, K.C., on the declaration of trust deed, and a letter from the Deputy Public Trustee, dated 27th January, 1914, were read. On the motion of Professor Farr, seconded by Professor Marshall, the matter was referred to the Standing Committee, with power to act.

Hector Memorial Award. — The report of the Award Committee was received in a sealed envelope. The President announced that the Committee recommended the medal should be awarded to Mr. Elsdon Best, of the Dominion Museum, Wellington, for his researches on the ethnology of New Zealand. On the motion of Mr. G. M. Thomson, seconded by Professor Kirk, the recommendation of the Committee was adopted.

Publication Committee Report.—The following report of the Publication Committee was received :—

PUBLICATION COMMITTEE REPORT.

The Publication Committee begs to submit the following report for the year :—

Seventy papers were forwarded for consideration ; of these, fifty-two were published in the Transactions (Vol. 45), and two were published in abstract in the Proceedings ; one was published in the "Journal of the Polynesian Society" ; several of the others were withdrawn, and the rest were declined. The Committee regrets that owing to the straitened finances of the Institute it was not possible to publish some papers that had been sent in, requiring a considerable number of illustrations.

Volume 45 of the Transactions was issued on the 9th June, and contains 490 pages of text and 17 plates (one coloured), besides a large number of illustrations in the text.

Bulletin No. 3, Part I, "Studies in the Bryology of New Zealand," by H. N. Dixon, M.A., F.L.S., of Northampton, England, was issued on the 30th June. It contains 29 pages of text and 4 plates, which were printed from blocks prepared by West, Newman, and Co., in England. The MS. for a second part of the bulletin, containing the continuation of Mr. Dixon's valuable investigations on the New Zealand mosses, has been recently received.

The two papers on New Zealand *Coleoptera* by Major Broun, the publication of which as Bulletins was authorized at last annual meeting of the Board of Governors, were sent to the printer early in the year, but owing to pressure of other work have not yet been published. Major Broun has forwarded this year another long paper on the same subject, which the Committee suggests should be issued uniform with the others in bulletin form.

Fifty-five papers have been received for the next volume of the Transactions, and a considerable number of these have already been sent on to the printer. The quantity of matter contained in these papers seems to be less than the average of past years.

The advisability of issuing the Transactions in two half-yearly parts was suggested at the last annual meeting. It is found, however, that under existing arrangements the pressure of work at the Governmnet Printing Office during parliamentary session makes the accomplishment of this difficult, and it has not been possible to do anything in the matter as yet.

For the Committee.

CHAS. CHILTON, R. SPEIGHT, } Hon. Editors.

On the motion of Dr. Cockayne, seconded by Mr. D. Petrie, power was given the Committee to publish the second part of Mr. Dixon's papers on New Zealand mosses. It was unanimously resolved that Major Broun be released from the terms of his guarantee in reference to the publication of his papers on *Coloeptera*.

Publication of Transactions.—It was proposed by Mr. Speight, seconded by Professor Farr, That, together with the Hon. Treasurer, the Publication Committee be instructed to consider and report to the next meeting of the Board on the possibility of issuing the Transactions more than once a year, —Carried.

Proceedings. — Mr. G. M. Thomson proposed, and Professor Kirk seconded, That the Publication Committee be asked to reconsider the advisability of renewing the publication of the Proceedings, and to report on the same at the next meeting of the Board.—Carried.

Exchange List Revision.—It was resolved, That the Standing Committee inquire into the matter of making slight alterations in the list.

Protection of Fur Seals. — A letter from the Secretary of the Marine Department (22nd December, 1913), with reference to the protection of fur seals, was received. The Standing Committee's action was approved.

Protection of Gannets. — On the motion of Mr. Hill, seconded by Mr. Stewart, it was resolved, That the preservation of the gannets on Cape Kidnappers be referred to the Standing Committee, with power to take such action as may be necessary.

Plumage Bill.—Letters from the Royal Zoological and Acclimatization Society of Victoria on the Plumage Bill were read, and, on the motion of Professor Kirk, seconded by Mr. G. M. Thomson, it was resolved, That the Institute approves heartily of the principles embodied in the Plumage Bill at present before the British Parliament, and asks the Government to bring in a Bill in the New Zealand Parliament embodying similar principles.

Panama Exposition.—A letter from the New Zealand Commissioner to the Panama Exposition, asking for the Institute's publications, was received. On the motion of Dr. Cockayne, seconded by Mr. Petrie, it was resolved, That the Standing Committee prepare an exhibit of the scientific work of the Institute and its branches for the Exposition.

Government Printer's Account.—The action of the Standing Committee in inquiring into the cost of printing illustrations was approved.

Correspondence.—Letters of acknowledgment and thanks were received from Messrs. Botting Hemsley (Kew), W. M. Davis (Harvard), A. H. Turnbull, and Sir Edward Thorpe (London).

Tongariro National Park.—Proposed by Dr. Cockayne, seconded by Professor Kirk, and carried, That the action being taken by the Manawatu Philosophical Society to secure an extension of the Tongariro National Park has the full sympathy of the Institute, and that the importance of such an extension be urged upon the Government.

Professor Dr. A. Engler.—Proposed by Dr. Cockayne, seconded by Mr. Petrie, and carried, That a letter be sent to Professor Dr. A. Engler, Director of the Berlin Botanical Garden and Professor of Botany in the University of Berlin, congratulating him on the occasion of his seventieth birthday.

Grasses of New Zealand.—Proposed by Mr. H. Hill, seconded by Dr. Cockayne, That the Government be recommended to issue a new publication of the native and introduced grasses of New Zealand, and that Mr. Petrie be appointed to edit the same.—Carried.

Scientific Library.—Proposed by Dr. Thomson, seconded by Mr. Speight, That the Board approves of the formation of a scientific library, as provided for under the Science and Art Bill, and is prepared to consider the handing-over of its library to the Scientific Library on conditions conserving the rights of its members, and that the Standing Committee be asked to report on the question.—Carried.

Mr. McNab's Researches.—Proposed by Mr. K. Wilson, seconded by Professor Kirk, That the Institute place on record its high appreciation of the value of Mr. R. McNab's researches on the history of New Zealand, and suggests to the Government that he should be formally accredited to the Government Departments of other countries and to such other authorities as may be able to give him access to the material of research.—Carried.

British Association Reception Committee.—Professor Easterfield gave a brief account of the work of the Committee.

Loan of Blocks.—A request from Dr. Cockayne for the loan of blocks of illustrations in the Transactions for use in his forthcoming work on the vegetation of New Zealand was granted.

Hamilton Memorial.—On the motion of the President, seconded by Mr. Hill, it was resolved, That the Board heartily approves of the steps taken by the Wellington Philosophical Society regarding the memorial to the late Mr. Hamilton, and cordially recommends the memorial to all members of the Institute.

Date and Place of next Annual Meeting.—It was decided that the next annual meeting be held at Wellington on Friday, the 29th January, 1915.

Travelling-expenses of Members.—It was resolved, That the travelling and hotel expenses of members of the Board be paid.

Honorary Members.—The following were elected honorary members of the Institute: Professor Haswell, Professor Bayley Balfour, and Dr. Newell Arber.

Election of Officers.—The following officers for the year were elected: *President*—Professor C. Chilton; *Hon. Treasurer*—Mr. C. A. Ewen; *Hon. Editor*—Professor C. Chilton; *Hon. Librarian*—Dr. J. Allan Thomson. *Publication Committee*—Professors Benham, Chilton, Farr, and Messrs. Speight and Thomson. *Secretary*—Mr. B. C. Aston. *Hector Award Committee for 1915*—Professor E. W. Skeats (Melbourne), convener; Professor David (Sydney); and Mr. W. Houchin (Adelaide). *Hutton Award Committee*—Professor Benham (Dunedin), convener; Dr. Cockayne; and Professor David (Sydney).

Secretary's Salary.—It was resolved that the Secretary's salary for the year be £50.

Votes of Thanks.—Hearty votes of thanks to the Hon. Editors and to the Hon. Treasurer were carried unanimously.

CHAS. CHILTON, Chairman.

Confirmed.
31st January, 1914.

PRESIDENTIAL ADDRESS.

The following is the presidential address delivered at the annual meeting of the Board of Governors of the New Zealand Institute, at Wellington, on the 30th January, 1914, by Charles Chilton, M.A., D.Sc., LL.D., F.L.S., Professor of Biology, Canterbury College:—

GENTLEMEN OF THE BOARD OF GOVERNORS OF THE NEW ZEALAND INSTITUTE,—At your last annual meeting you were good enough to elect me, in my absence, to be your President for the year, and my first duty is now to thank you most sincerely for the great honour you thus conferred upon me. By custom, now well established, the position carries with it the duty of presenting to you some address on the work of the Institute during the year, and of other scientific matters in which the Institute is directly interested.

Since our last meeting, Augustus Hamilton, Director of the Dominion Museum, who has been a member since the Board was reconstituted in 1903, and who has acted throughout as our Librarian and has also held the offices of President and Editor, has been removed by death. As a collector, an explorer, and a bibliographer he has made a name for himself, and has rendered most valuable service to the cause of New Zealand science; while by his researches and publications on Maori ethnology, particularly by his splendid volumes on "Maori Art," he established a reputation as the chief authority on that department of science, and has preserved for all time some of the most valuable memorials of our Native race, which but for his industry and enthusiasm might have been lost for ever. We shall miss his advice at our meeting, and the Institute will be the poorer for the want of his ripe judgment and wide experience. An appreciation of his labours will naturally find a place in the next volume of our Transactions, and it is gratifying to know that a movement has already been made for the erection of some permanent memorial to remind our successors of his life and work.

In the list of our honorary members the losses by death have this year been unusually numerous: Lord Avebury, John Milne, P. L. Sclater, Sir George Darwin, and Alfred Russel Wallace, all of them men prominent in science. The mention of Alfred Russel Wallace, especially well known and honoured by New-Zealanders for his researches in connection with the origin of our fauna and flora, takes us back to the publication of the theory of Natural Selection by Darwin and Wallace in 1858, and reminds us of the vast amount of work in zoology and botany during the latter half of the nineteenth century that resulted from the stimulus of that discovery, and of its still more important influences in other fields of thought and activity.

Since Captain Scott first came to New Zealand in 1901 in the Antarctic exploring ship "Discovery" we have felt personally interested in Antarctic research, and early last year we had been hoping to welcome back the "Terra Nova" with her officers and men after the successful achievement of the work they had set out to do. The success was achieved in spite of extraordinary and unusual hardships and dangers; there is no question of the value of the scientific results of the expedition; and, though the leaders sacrificed their lives in the work, their end was so nobly heroic, and surrounded by so bright a cloud of glory, that but for our personal grief we could hardly wish it otherwise.

In connection with the Australasian Antarctic Expedition, under Dr. Mawson, in which two New-Zealanders have played a worthy part, we have to record the same mingling of successful achievement and sad loss of human lives. We trust that the valuable results already gained will be greatly added to by the enforced continuance of the expedition in the Antarctic for an additional year, and that in the near future we shall be able to welcome the return of the party all safe and well.

By the publication of the results of these two expeditions, and of the German expedition in the "Deutschland," and by the further volumes recording the results of earlier expeditions, our knowledge of the Antarctic is being gradually extended, and the parts still unknown more and more narrowed; while, undismayed by the known difficulties and dangers and by the memory of previous disasters, Sir Ernest Shackleton, Lieutenant Stackhouse, and others are planning fresh expeditions to solve the questions still requiring answer. If these expeditions meet with the success they deserve—as we all hope they will—the Antarctic will soon be one of the best scientifically explored portions of the earth, and the New Zealand problems connected therewith will be within measurable reach of satisfactory solution.

Of the various matters to be brought before your notice at this meeting there are only a few that I need specially call your attention to now.

At its last annual meeting this Board supported, with certain alterations, the proposals previously made by a parliamentary Committee for the establishment of a Scientific Board of Advice, with the object of securing greater uniformity in the various scientific publications of the Government Departments, and of giving advice in connection with these and other scientific questions likely to be brought before the Government, and we had hoped that effect would be given to these recommendations by Parliament at its last session. A Science and Art Bill was introduced providing for the establishment of a Board to control the Dominion Museum and a National Art Gallery, and to decide what scientific reports should be printed or reprinted. In this Bill as introduced the proposed Board was also given control over the "Transactions of the New Zealand Institute," both as regards the papers to be included and the price at which the volume could be supplied to members. Strong exception to these proposals was at once made by nearly all the local Institutes, and a special meeting of this Board was summoned for the 5th September to consider the position, and as a result the clauses dealing with these matters were struck out of the Bill, and the Act as passed leaves to the Institute the full control of its own Transactions, as provided for in the New Zealand Institute Act, 1903.

The main reason for proposing to place the publication of the Transactions under the control of the Board established by the Science and Art Act was to relieve the Institute of the cost of printing the Transactions, so that it might have the annual grant of £500 free for encouraging science in other ways. As you are well aware, the annual grant is barely sufficient for the publication of the Transactions in ordinary years, and it so happened that three or four years ago we had several years in succession particularly fruitful in the production of papers by members of the Institute fully deserving of publication, and additional expense was also caused by the issue of the Index to the first forty volumes, of special Bulletins, by the separate publication and distribution of the Proceedings, and by holding the Board's meetings for two years at centres other than Wellington; and the consequence was that the credit to the balance of the Institute was for the time converted into a debit. In consequence the Board was forced to stop the separate issue of the Proceedings, to discontinue for a time to issue Bulletins, and to intimate to the members of the Publication Committee that they must bear in mind the straitened finances when deciding the papers that were to be printed in the Transactions. These economies have been duly carried out, and in response to the representations of Mr. G. M. Thomson and other members of Parliament the Government voted an additional £250 for the funds of the Institute in 1912 and again in 1913, so that there seems reasonable prospect of the Institute's funds being in credit at the end of this year. From one point of view this will doubtless be regarded as satisfactory; but the reputation of a

scientific society is judged by the number and value of its publications, and not by its credit balance in the bank, and I am very much afraid that the measures the Board was obliged to take have had a discouraging effect on the production of original work by the members of the Institute. To my mind, the surest and most natural way of encouraging original research is to provide ample facilities for the publication with the least possible delay of all the results that are deserving of being so published. Particularly do I deplore the discontinuance of the issue of the Proceedings in several parts during the year. The arrangements for their issue in the form they were beginning to assume entailed a very considerable amount of work for the Hon. Editors and the Publication Committee, but the frequent issue of the Proceedings was affording a very useful means of letting members of one district Institute know what the others were doing; and there is no doubt that they were encouraging work, especially by many of our younger members, by the speedy publication of short papers and notes embodying original observations that would never have been preserved if they had had to be held over for many months for the yearly volume of the Transactions; moreover, we must remember that every published paper tends to suggest and stimulate the writing of others.

It is evident that if the ordinary expenses of this Board and the printing of our publications are to be limited to what can be done with the yearly grant of £500 the usefulness of the Institute will be very greatly hampered, and that it will be unable to take that large and increasing share in promoting science that we all wish to see it perform. The claim that has been made for an increase in the statutory annual grant is therefore fully justified; and if we consider the conditions of the country and of the Institute when the grant was fixed at £500, forty-five years ago, and compare them with the present, it will be seen that if the grant were doubled it would only be bringing it into reasonable relation to the requirements of the Institute for the immediate future, and that the whole of it could be used with great advantage. Personally, however, I am of opinion that the Institute will never be able to take that independent position that is absolutely essential for the real success of a purely scientific society so long as we are entirely dependent on a Government grant, and I look forward to the time when we shall be freed from that dependence by the receipt of funds from other sources. I will return to this point presently.

But there is another unsatisfactory feature in connection with our finances. Naturally, we wish to see the Institute's work extended and the number of its members increased, and yet under our present regulations increase of membership, far from strengthening our financial position, weakens it by necessitating the issue of additional volumes of the Transactions without any additional increase to our funds. This is essentially an unstable position. By the Act, every member of the district Institutes is *ipso facto* a member of this Institute, and every additional member of the Institute should be an addition to its strength financially as well as scientifically. It seems to me that this can only be done by a levy or contribution per member towards the general funds of the Institute. This need be only very small in amount; half a crown per member would be quite sufficient, and would materially strengthen our funds. The proposal is by no means new; in the history of our own Institute there are instances where a levy on the district Institutes has been made for the funds of the controlling body, and it is the method adopted by practically every body that consists of branches the common interests of which are entrusted to and controlled by a central executive. In the case of the Institute it would have other advantages. Some of the smaller Institutes find it difficult to continue as purely scientific societies requiring the usual subscription of one guinea for membership, and are forced either to reduce the fee or to offer other advantages of membership of a different character, while they still claim that they are entitled to a copy of the Transactions for each member. If by regulation these Institutes paid to our funds a small contribution for each member requiring the volume, it would enable us to define accurately the members of the Institute entitled to this privilege, while the local society would still be free to accept associates on other conditions, and, if they wished, at a lower annual subscription; and the unfortunate differences which have in some cases occurred as to the number of volumes claimed would no longer arise. It would also enable any Institute to establish sections for particular purposes, and to allow of membership of the sections on special conditions, without raising questions as to whether they were to be considered members of the Institute or not.

This, then, would be one means of strengthening our finances, and there are other methods that I need not enter upon now, but there is one general source that I wish to refer to. Other learned societies usually have considerable sums donated or bequeathed to them either for general purposes or for some special research or investiga-

tion. The New Zealand Institute has hitherto received very little in this way. We have the Carter Bequest for a special purpose, for which we have so far been unable to make proper provision; and we have the Hector and Hutton Funds, raised by contributions from our members, aided by Government subsidies, and these funds are performing the useful function of perpetuating the memory of those in whose honour they were established, and in stimulating research in New Zealand science. But when the needs of the Institute and the facilities it possesses for promoting the welfare of the country by the researches of its members are known, is it too much to hope that we shall receive many other contributions from private liberality? In this country, so blessed with natural advantages that make for prosperity, and where so much is spent on sport and pleasure, on motor-cars, racehorses, and golf, surely we ought to be able to count upon subscriptions from this source equal at least to the cost of one motor-car per year. Many of our citizens have made most generous gifts for the support of educational and religious institutions, for art galleries and libraries, and it is with sincere pleasure and gratitude that I refer to the great assistance given to the Nelson Institute by Mr. Thomas Cawthron, and to his munificent gift for the establishment of an astronomical observatory at Nelson. So far as I am aware, this is the first great gift in New Zealand for the promotion of pure science, and it sets an example worthy of imitation by others.

I need hardly remind you that the meeting of the British Association this year is to be held in Australia, and that many distinguished men of science are coming from Europe to attend its meetings at Perth, Adelaide, Melbourne, Sydney, and Brisbane. It is hoped that the great attractions of our New Zealand zoology, botany, and geology will induce many of these members to extend their visit to New Zealand, and that we shall have the great advantage of being able to meet them, of showing them what is worthy of scientific interest in New Zealand, and of receiving their advice and assistance in connection with the work that is still to be done. An energetic committee in Wellington has long been at work making the necessary arrangements, a substantial grant for the expenses has been made by the Government, and there is little doubt that very great benefit to New Zealand science will be the result.

It gives me great pleasure to be able to report that the text of Mr. Suter's "Manual of the New Zealand Mollusca" has at last been issued, and is being distributed by the Education Department. The work was recommended many years ago by our Institute, and though it has been long delayed for various reasons, into which I need not now enter, it is gratifying to know that it has at last appeared, and we can congratulate the author on its publication and on the faithful and conscientious work in this subject that he has performed with such painstaking industry for so many years. The plates to illustrate the work have long been in hand, many of them are already prepared, and we must relax no effort in seeing that the same delay in their production does not occur as there was with the text. The work will be of very great value not only to zoologists, but more particularly to palaeontologists, and I have little doubt that it will greatly aid in the solution of many geological problems that still require working out.

There is a still more important subject that I must speak about. The unsatisfactory housing of the valuable specimens and the Institute library in the Dominion Museum has been drawn attention to time after time by the Director and by others; and my predecessor in this office, Mr. T. F. Cheeseman, in his address last year, speaking of the library, declared that the condition of affairs was a disgrace both to the Government and to the Institute. I feel it my duty, as the President of this Institute, to repeat that statement in the most emphatic manner possible. The Museum contains a vast collection of valuable specimens of Maori art and workmanship, of geological and zoological specimens, including the very large and valuable collections of insects gathered with so much energy and judgment by the late Director; and it contains the very valuable library of the Institute. The great majority of these are quite irreplaceable, yet they are still housed in a wooden building that is almost falling to pieces through age, and the greater part of which has been declared to be insanitary for human beings. Despite the repeated appeals, little or nothing has been done to remedy this state of affairs. It is true that a Science and Art Act was passed at last session of Parliament, setting up a Board for the control of the Dominion Museum; but an Act of Parliament is not an efficient fire-preventive, nor has it any inherent power of counteracting the effects of damp and mould in a wooden building that lets in the rain at all places; and many of the specimens, collected at the expense of the life-blood of Sir James Hector and of Mr. Hamilton, are rapidly being ruined, while the whole collection might be destroyed by fire in a single night, to the eternal disgrace of New Zealand. Whose fault is it? It is no use our blaming the Government. Ministers come and Ministers go, and they have many things to think of that

appear to them more important than the proper housing of a unique and priceless series of scientific specimens; but this Institute has a continuous existence as the embodiment of the scientific opinion of New Zealand, and knows what requires to be done, and I am afraid that we have not made our influence in this matter felt in the way that we should have done. The methods of the agitator who manœuvres the newspapers for his particular purpose are extremely distasteful to me; but unless some radical improvement is very soon made, it seems to me that it will be the duty of this Institute to take advantage of every available means of bringing this state of affairs prominently before the people of New Zealand and to continue to agitate on the matter until the Museum collections are housed in a permanent building as fireproof as it is possible to make it.

But we have a still larger and more important museum entrusted to our care—the zoology, botany, and geology of New Zealand, with its specimens of ancient types, not only found nowhere else in the world, but in so many cases connecting our present plants and animals with those that lived on the earth in former geological ages, and that have become extinct everywhere else. Our botanists have repeatedly pointed out that the flora of New Zealand presents in a comparatively small space all the types of vegetation to be found in the world. It contains many plants found only in particular localities in New Zealand, of extreme interest, and many also of great economic value. The same thing is true of our animals. Every one knows of our tuatara, which a late distinguished zoologist once described as the animal most important zoologically on the face of the earth; but among the smaller animals there are many types almost as extraordinary, and as well deserving of full and careful study. It is true that a good deal has been done in the work of investigating some of these, but the subject has only been touched on the surface, and there is much that has not yet been attempted at all. Our first duty, however, is to see that these objects are, so far as possible, preserved, so that they may be worked out by our successors, if not by ourselves. Meanwhile our forests are being destroyed at an alarmingly rapid rate, and often for most insufficient reasons, and with them are destroyed also the smaller insects and other animals that live in the bush. Very many of these have not yet been collected or investigated, and they are rapidly becoming extinct. In some notes for a lecture found among a few papers left by the late Captain Hutton, and entrusted to me, there is a pathetic reference to this matter, in which he gives expression to his grief at the small amount of work that it has been possible to do at the entomology of New Zealand; and I can share his grief, while at the same time recognizing with gratitude what has been done by Captain Hutton himself, Mr. G. V. Hudson, and other workers.

If this Institute is to take its proper share in the scientific work of New Zealand, its first and most urgent duty, it seems to me, is to secure the preservation of all objects of scientific importance in New Zealand that are liable to be destroyed. The memorials of the Maori race I have already referred to, but we have also to protest against the unnecessary destruction of our forests, and to see that sufficient is preserved untouched on all hilltops and in valleys and other places where it is possible to preserve it without interfering with the advance of settlement, and that specimens of all plants and animals likely to become extinct are collected and properly and permanently preserved. If we are to do this, and to perform satisfactorily the other duties of a scientific society, we must act more energetically than we have sometimes done in the past, and act so that this Institute may become what it should be—the powerful and independent expression of scientific opinion in New Zealand, and the authority to which all would turn who require information or advice on scientific matters. That position we have not yet attained. Acts dealing with scientific matters are passed by Parliament, regulations regarding fisheries or sealing are gazetted, scientific appointments are made by the Government, by University Colleges and others, Royal Commissions dealing with scientific questions are set up, and scientific works are published at public expense without the opinion of this Institute being sought or obtained. Surely we have the knowledge, the ability, and the courage to give a valuable and independent opinion on matters of this kind, and it is our duty so to promote the true interests of the Institute and to make it such an important body that its advice will naturally be sought by all who require it on these matters, and be an indispensable preliminary to action.

AUCKLAND INSTITUTE.

FIRST MEETING: *9th June, 1913.*

C. J. Parr, Esq., Mayor of Auckland, President, in the chair.

New Members.—F. L. Broadgate, L. T. Griffin.

Lecture.—"Serums and Vaccines, with Special Reference to Dr. Friedmann's Treatment of Tuberculosis," by F. L. Armitage.

The lecturer endeavoured to show how the body fights disease through the use of serums and vaccines. He explained the nature and preparation of diphtheria antitoxin as an example of a serum, of smallpox and hydrophopia vaccines as examples of vaccines of unknown organisms, and of ordinary bacterial vaccines and tuberculin. The nature of Dr. Friedmann's vaccine was explained, and its prospective value and limitations discussed.

The lecture was illustrated with specially prepared lantern-slides.

SECOND MEETING: *14th July, 1913.*

Professor H. W. Segar, Vice-President, in the chair.

New Member.—F. W. Leighton.

Lecture.—"Modern Developments of Electrical Engineering," by Mr. W. Wilson, M.Sc.

The lecture was profusely illustrated with lantern-views and the working of apparatus.

THIRD MEETING: *4th August, 1913.*

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—"A Visit to White Island, the Active Volcano in the Bay of Plenty," by Mr. W. R. B. Oliver.

In addition to a description of White Island, its physiography and volcanic phenomena, its plant and bird life, the lecturer gave some account of the structure and distribution of volcanoes, with special reference to the line of active volcanoes stretching from Ngauruhoe to Tonga and Samoa.

FOURTH MEETING: *15th September, 1913.*

C. J. Parr, Esq., Mayor of Auckland, President, in the chair.

Lecture.—"Town-planning," by Mr. C. J. Parr.

This was an attempt to show what principles should be adopted to provide for the expansion of a young and growing city, with special reference to the case of Auckland, and was illustrated by numerous lantern-slides.

Fifth Meeting, *29th September, 1913.*

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—" Surface Combustion," by Professor F. D. Brown.

The lecturer stated that during the active search made throughout the industrial world of late years to discover improved methods of using fuel it had been found that by utilizing the very interesting phenomenon known as " surface combustion " remarkably economical results had been obtained. The object of the lecture was to give a general idea of what surface combustion meant, and how it could be applied in the arts. Numerous experimental illustrations were provided during the lecture.

At the close of the lecture the Chairman called the attention of the meeting to the fact that it was the last occasion on which they would have the privilege of listening to Professor Brown in his capacity of a Professor of the Auckland University College. He moved, That the thanks of the Institute be tendered to Professor Brown for his services to the Institute, and that, while expressing regret at his retirement, the Institute trusted that he would have a long and prosperous future. The motion was seconded by Mr. James Stewart, as one of the few surviving members of the first Council of the Institute, and was supported by Mr. T. Peacock, Mr. J. A. Pond, Mr. H. B. Morton, and other members of old standing. Professor Brown suitably replied.

Sixth Meeting : *8th October, 1913.*

C. J. Parr, Esq., Mayor of Auckland, President, in the chair.

This meeting, which was held in the exhibition halls of the Auckland Museum on the occasion of the installation of the restoration of the moa (*Dinornis maximus*) and other important additions to the Museum, took the form of an informal conversazione, and was attended by over five hundred members and their friends.

During the evening the President congratulated those present on the important additions made to the collections, and announced that the Hon. E. Mitchelson had that day presented to the Museum his unique collection of specimens of kauri-gum, valued by experts at a sum not much below £1,000. A vote of thanks to the Hon. E. Mitchelson was passed by acclamation.

Seventh Meeting : *20th October, 1913.*

C. J. Parr, Esq., Mayor of Auckland, President, in the chair.

New Member.—H. Larkin.

Lecture.—" The Kauri Pine : its History and Peculiarities," by Mr. T. F. Cheeseman, F.L.S., F.Z.S.

Eighth Meeting : *3rd December, 1913.*

Professor H. W. Segar, Vice-President, in the chair.

Papers.—1. " New Species of Phanerogams," by D. Petrie, M.A.

2. " Additions to the Flora of the Westport District," by D. Petrie, M.A.

3. " Occurrence of *Poa antipoda* on Herekopere Island," by D. Petrie, M.A.

4. " Notes on *Cephalopoda* from the Kermadec Islands," by S. S. Berry ; communicated by W. R. B. Oliver.

5. " Contributions to a Fuller Knowledge of the Flora of New Zealand," by T. F. Cheeseman, F.L.S., F.Z.S.

6. "The Age and Growth of the Kauri Pine," by T. F. Cheeseman.
7. "Notes on *Pittosporum Dallii*," by T. F. Cheeseman.
8. "Description of a New *Celmisia*," by T. F. Cheeseman.
9. "New Genera and Species of *Coleoptera*," by Major Broun, F.E.S.

Annual Meeting: *23rd February, 1914.*

C. J. Parr, Esq., Mayor of Auckland, President, in the chair.

Annual Report.—The annual report and audited financial statement was read to the meeting, and ordered to be printed and distributed among the members.

Abstract of Annual Report.

Members.—The number of new members elected during the year has been unusually small, amounting to five only. No doubt the reason for this is the canvass instituted last year, which resulted in the addition of 162 names to the roll. The names withdrawn from the roll during the year number twenty-one—six from death, and the remainder from resignation or non-payment of subscription for more than two consecutive years. This leaves the total membership at the present time at 370. It is satisfactory to be able to state that the Auckland Institute still retains the premier place among the incorporated societies so far as regards the number of members.

The Council have much regret in announcing the death of Mr. James Stewart, who has been associated with the Institute since its formation in 1868, and who has always taken a steady and consistent interest in its affairs. He has twice served as President, and, with two short intervals, has been a member of the Council since 1871. In 1906 he was appointed a Trustee, a position which he occupied up to the time of his death. The Council desire to express their high appreciation of the many services he has rendered to the Institute during his long and active membership.

All branches of the New Zealand Institute, and all workers engaged in scientific research in New Zealand, will regret the sudden death of Mr. A. Hamilton, late Director of the Dominion Museum, and a former President of the New Zealand Institute. The Council are anxious to place on record their high sense of the valuable nature of his work, more especially that portion of it dealing with the ethnology of the Maori race.

Finance.—The total revenue of the Working Account, excluding the balance in hand at the beginning of the year, has been £1,862 0s. 2d. This shows an increase of £508 7s. on the receipts for the previous year, which were £1,353 13s. 2d. Half of this increase is due to the payment of the Government subsidy of £250, which it will be remembered was voted by Parliament during the session of 1912 in recognition of an amount of £684 previously subscribed by the citizens of Auckland for the purchase of certain special additions to the Museum. The total expenditure has been much larger than usual, amounting to £1,590 10s. 2d., as against £1,465 5s. 10d. for the previous year. The increase is principally due to the expenditure on the large group of flightless birds recently installed in the Museum, and to the cost of the show-cases required for it and other important additions. The balance in hand at the present time amounts to £379 11s.

The legacy of £1,000 bequeathed by the late Sir John Logan Campbell has been paid by the Campbell trustees during the year, and added to the invested funds of the society. A further sum of £110 10s., derived partly from the sale of Museum endowments and partly from the life subscription account, has also been received. From these two sources the Capital Account of the Institute has been raised to the sum of £17,626 8s. 6d., almost the whole of which is now invested in specially selected freehold securities.

Meetings.—Seven meetings have been held during the year, at which fifteen lectures and papers have been contributed by various members.

Science and Art Bill.—During the last session of Parliament a Bill was introduced under the title of the Science and Art Bill, which, among other objectionable provisions, included certain clauses which imperilled the future existence of the New Zealand Institute as a self-governing body, and which provided for changes in the mode of publishing and distributing the Transactions which would have greatly hampered the operations of the Institute, and which would have made it subservient to a body mainly composed of the Government nominees to be set up under the Bill. The Council are glad to state

that, mainly through objections raised by the various societies incorporated with the Institute, these clauses were struck out of the Bill during its passage through Parliament.

British Association.—The next meeting of the British Association will be held in Australia in the month of August, and arrangements have been made by the Government to invite a number of the delegates to visit New Zealand early in September. A suggested programme, prepared by a reception committee sitting in Wellington, provides for the arrival of the visitors in Auckland and their immediate journey southwards to Wellington and Christchurch, in each of which towns a stay of three or four days is to be made, and meetings held. The Council are endeavouring to obtain an alteration of this programme under which a visit of reasonable duration may be made to Auckland.

Museum.—The number of visitors to the Museum has been very close to last year's record.

The most noteworthy improvement made in the Museum during the year has been the installation of a large group of flightless birds, including a restoration of the largest species of moa (*Dinornis maximus*); a full-sized model of the skeleton of the same, obtained from the well-known dealer, Mr. Damon; an actual skeleton of a smaller species of moa; a mounted specimen and a skeleton of the ostrich; an adult and a young emu; and two cassowaries. The whole group has been placed in a plate-glass show-case standing in the centre of the main hall.

Another conspicuous addition to the Museum is a group of birds of paradise, containing in all thirty-seven specimens of thirteen different species.

In order to bring these additions and many minor ones under the notice of the members and the citizens of Auckland generally, the Council decided that they should be inaugurated at a conversazione of members and their friends. This was held on the evening of the 8th October, 1913, and passed off most successfully, an attendance of about 550 being present.

The most important donation made to the Museum during the year is the Hon. E. Mitchelson's collection of kauri-gum, together with the plate-glass show-case in which it is exhibited. This collection, which has taken over forty years to form, and which includes picked examples of most, if not all, of the known varieties, is acknowledged to be the most complete in existence.

Several additions of importance have been made to the Maori collections by Dr. Roger Buddle, Mrs. George Humphries, Mr. George Wootten, Miss M. Makai, Mr. Griffin, Mr. Robison, Mr. A. E. Bregmen, and Mr. J. B. Thompson. In foreign ethnology the only addition of importance is a fine collection of weapons, implements, ornaments, &c., from the Louisiade Archipelago, purchased from Mrs. Ansley.

Library.—An expenditure of £190 has been incurred on the library during the year. In addition to the purchase of books, the magazines and serial publications subscribed to by the society have been regularly received and circulated among the members. A portion of the expenditure has been devoted to the binding of these serials, and over seventy volumes have been added to the library from that source alone. Of several donations from private individuals the most important is the presentation by Professor Brown of thirty-two volumes of the "Annalen der Physik."

Further Accommodation required.—Two years ago the Council called attention to the drawbacks and deficiencies which, through want of space, impede the development of both the Museum and library, and will continue to do so in an increasing ratio until an enlargement of the buildings of no small size can be obtained. At the present time, if it is desired to show new additions of importance, room can only be found by withdrawing articles already on exhibition.

Last autumn a deputation from the Council waited upon the Premier in order to press upon his notice the claims of the Museum for a grant in aid of a Building Fund. Although the deputation was sympathetically received, the wave of financial stringency then passing through the Dominion precluded any hope of immediate monetary assistance. A promise, however, was made to the effect that the application would be favourably considered during the session of Parliament to open in June next. It will be the duty of the incoming Council to bring the matter once more under the notice of the Government, and to take such steps to support the application that may appear to be requisite.

Election of Officers for 1914.—President—C. J. Parr, Esq., Mayor of Auckland; *Vice-Presidents*—Professor H. W. Segar, J. H. Upton; *Council*—Dr. R. Briffault, R. E. Burns, Professor C. W. Egerton, E. V. Miller, the Hon. E. Mitchelson, T. Peacock, J. A. Pond, J. Reid, D. Petrie, Professor A. P. W. Thomas, H. E. Vaile; *Trustees*—T. Peacock, J. Reid, J. H. Upton; *Curator and Secretary*—T. F. Cheeseman; *Auditor*—S. Gray.

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting: *30th April, 1913.*

Professor T. H. Easterfield, President, in the chair, and about forty members and friends.

New Member.—Mr. G. G. Bridges.

The President announced that Mr. G. V. Hudson had resigned from the Council, and that the Council had elected Mr. L. Birks as a member of the Council.

Alteration of Rules.—A new rule was adopted giving the Council power to elect as a life member—(1) Any member of the Society who, in the opinion of the Council, has given the Society specially meritorious service, provided that the number so elected in any one year shall not exceed one; or (2) any member of the Society who has paid his subscription to the Society for thirty years, and who intimates to the Council his desire to become a life member; or (3) any member of the New Zealand Institute who has paid his subscription to one or more of the affiliated societies for thirty years, and who after taking up his residence in Wellington intimates to the Council his desire to become a life member.

Ex-Presidential Address.—"Some Recent Advances in Chemistry," by Professor Easterfield.

Second Meeting: *28th May, 1913.*

Professor T. H. Easterfield, President, in the chair, and about sixty members and friends.

New Members.—Mr. W. R. Morris, Mr. F. H. Bakewell, M.A., Mr. W. O. Beere, and Mr. W. H. Hodson.

A discussion took place on the presidential address of Professor E. A. Schaefer, D.Sc., F.R.S., delivered at the Dundee meeting of the British Association for the Advancement of Science, on the nature, origin, and maintenance of life.

Professor Easterfield, on the invitation of the Council, gave a summary of the address. Professor Kirk criticized the views of Professor Schaefer, giving his reasons at length; while Dr. C. M. Begg supported Professor Schaefer.

A general discussion then took place, to which Mr. F. G. A. Stuckey, Dr. Cockayne, Mr. G. V. Hudson, Professor Laby, Mr. H. L. James, Mr. W. H. Hodson, and Professor Hunter contributed.

Professor Kirk then replied to the points raised in the general discussion.

THIRD MEETING: *25th June, 1913.*

Professor T. H. Easterfield, President, in the chair, and about fifty members.

Technological Section.—In accordance with notice of motion given at the May meeting, Mr. R. W. Holmes moved, That a Technological Section of the Society be formed. Seconded by Mr. W. Ferguson. After discussion by Mr. G. V. Hudson and Mr. P. G. Morgan, the motion was carried, Mr. Hudson dissenting.

Exhibits.—Professor Laby exhibited and described electrical apparatus for use with alternating currents.

Mr. C. A. Cotton exhibited and described apparatus for opaque projection.

Mr. W. A. Stewart exhibited some photographs showing the reflection of X-rays.

Papers.—1. "The Calibration of Copper Constantan Thermo-electric Couples," by Mr. E. O. Hercus, M.Sc.

Professor Laby and Mr. Adams congratulated Mr. Hercus on the work he is doing.

2. "The Nature of Gamma Rays from Radium," by Mr. P. W. Burbridge, M.Sc.

The President congratulated Mr. Burbridge on winning the 1851 Exhibition Science Scholarship.

Lord Avebury.—Mr. G. V. Hudson referred to the recent death of Lord Avebury, and moved, That the Society expresses its keen sense of regret at the great loss to science, and to the world in general, through the death of Lord Avebury.

SPECIAL MEETING: *7th July, 1913.*

The meeting was held in the Concert Chamber, Town Hall.

His Worship the Mayor presided over a large audience, and introduced Dr. Chilton, President of the New Zealand Institute.

Hector Medal.—Dr. Chilton gave an account of the foundation of the Hector Fund, and stated the Hector Medal had been awarded to Professor Easterfield for researches in chemistry.

His Excellency the Governor, Lord Liverpool, then presented the medal to Professor Easterfield, and congratulated him, and invited him to give some information of his own and his students' work.

Professor Easterfield gracefully acknowledged the aid which he had received from demonstrators and students in his laboratory.

Lecture.—Dr. Chilton then delivered an interesting lecture "On the Biological Results of Antarctic Exploration."

The lecture was illustrated by many fine lantern-slides.

FOURTH MEETING: *30th July, 1913.*

Professor T. H. Easterfield, President, in the chair, and about forty members.

New Members.—Messrs. F. W. MacLean, F. Reed, A. Atkins, P. H. R. Miles, J. R. Smith, A. Gibbs, K. R. Orchiston, D. E. Parton, E. W. Ackland, A. H. Alabaster, C. G. Johnston, G. V. R. Fraser, S. H. Jenkinson, D. K. Blair, John P. Luke, W. H. Morton, and A. Dougall.

Geological Section.—Mr. P. G. Morgan moved, That a Geological Section of the Society be formed. Seconded by Mr. C. A. Cotton, and supported by Dr. Allan Thomson, and carried unanimously.

Address.—"Experimental Psychology in Australasian Universities," by Professor Hunter.

An interesting discussion followed, in which Mr. Morgan, Professor Kirk, Mr. Thomas Ward, and the President took part.

Professor Kirk moved that the Society endorses the following resolution, which was passed at the last meeting but one of the Australasian Association for the Advancement of Science: That it is important in the interests of higher education that additional teaching should be provided in the department of philosophy, more especially in the subjects of sociology and experimental psychology. Seconded by Mr. P. Levi, and carried.

Paper.—"The Natives of South-east Papua," by Mr. D. Jenness, M.A.

FIFTH MEETING: *27th August, 1913.*

Professor T. H. Easterfield, President, in the chair, and about forty members.

New Members.—Miss Kilroe, Mr. K. E. Luke, Mr. C. G. Swinburne, Mr. J. M. Morice, B.Sc., and Mr. C. E. Richardson.

Science and Art Bill.—The President drew attention to the Science and Art Bill, and urged all members to study it.

Papers.—1. "Some Intrusive Igneous Rocks from the Westport District," by J. A. Bartrum, M.Sc.

2. "Description of a Collection of Actinians from the Kermadec Islands," by F. G. A. Stuckey, M.A.

3. "Controversial Points in the Geology of the Marginal Rocks of the East Coast of New Zealand," by Dr. J. Allan Thomson and Mr. C. A. Cotton, M.Sc.

SIXTH MEETING: *24th September, 1913.*

Professor T. H. Easterfield, President, in the chair, and about twenty-five members.

Papers.—1. "Notes on some Recent Earthquakes," by G. Hogben, M.A., F.G.S.

2. "Preferential Voting for a Single-member Constituency," by G. Hogben, M.A., F.G.S.

3. "Errors in the Tasmanian System of Proportional Representation," by G. Hogben, M.A., F.G.S.

ANNUAL MEETING: *22nd October, 1913.*

Professor T. H. Easterfield, President, in the chair, and about forty members.

Death of Mr. Augustus Hamilton.—Before beginning the business of the evening the President made the following remarks:—

I cannot commence the business of the evening without first referring to the great loss which the Society has suffered by the death of Mr. Augustus Hamilton. Mr.

Hamilton joined the Society thirty-eight years ago, and three years later contributed his first paper, dealing with the botany of the Okarito District of Westland. Since that date he contributed a very large number of papers to the "Transactions of the New Zealand Institute." Mr. Hamilton's sympathies were very wide. He was interested in coins, stamps, minerals, plants, insects, shells, fish, birds, Native races, and in all matters relating to art. This combination of interests, together with his untiring energy, made him an ideal Curator for our Dominion Museum, and all must regret that his ideal of a Dominion Museum building worthy of the collection, which owed so much to his efforts, has remained unrealized.

On the motion of the President, seconded by Dr. C. Monro Hector, the following resolution was passed: "The Council of the Wellington Philosophical Society expresses its deep regret at the death of Mr. A. Hamilton, a former President of the Society, and an honorary life member. Mr. Hamilton's great ability and energy, his wide sympathies and catholic tastes, placed him amongst our public men. His services to art and science are evidenced by the large quantity and sterling quality of his published work. On behalf of the Wellington Philosophical Society, the members of the Council desire to express their sense of the great loss which the Society and New Zealand culture have sustained, and to express to the relatives of Mr. Hamilton their sincerest sympathy."

New Members.—Mr. T. O. Fox, Mr. J. D. Holmes, Mr. E. W. Hursthouse, Mr. L. Moore, Mr. R. E. Robertson, Mr. F. E. Widdop, Mr. H. J. Wynne, Mr. H. J. H. Blow, Mr. E. A. Shrimpton, and Mr. G. Stewardson.

Annual Reports.—The annual report and balance-sheet were read and adopted.

The annual reports of the Astronomical, Technological, and Geological Sections were also read and adopted.

Mr. G. V. Hudson, speaking to the annual report, regretted the almost complete disappearance of original papers on New Zealand natural history, and objected to the formation of sections of the Society, as tending to reduce the interest of the ordinary meetings.

Election of Officers for 1914.—President—Dr. C. Monro Hector, M.D., B.Sc.; *Vice-President*—Mr. Thomas King, F.R.A.S.; *Council*—Dr. J. Allan Thomson, D.Sc., Professor T. H. Easterfield, M.A., Ph.D., Mr. G. Hogben, M.A., Mr. R. W. Holmes, M.Inst.C.E., Mr. B. C. Aston, F.C.S., F.I.C., Mr. E. Parry, B.Sc., M.I.E.E.; *Auditor*—Mr. E. R. Dymock, A.I.A.

Papers.—1. "Notes on Phosphorous and Phosphoric Acids," by Mr. J. G. Fulton.

2. "The Unfit: an Educational Problem," by Miss P. Myers, B.A.

Both papers gave rise to interesting discussions, in which Dr. Thomson, Professor Easterfield, and Mr. G. Hogben took part.

3. "Notes on a Tide-predicting Machine," by Mr. C. E. Adams.

4. "Harmonic Tidal Constants of New Zealand Ports—Dunedin and Port Chalmers," by Mr. C. E. Adams.

5. "Plant-habitats Hitherto Unrecorded," by Mr. B. C. Aston.

6. "Botanical Notes on an Ascent of the Ruahine Mountains at Makaretu," by Mr. B. C. Aston.

7. "List of Plants and Brief Ecological Remarks on certain Little-known Localities," by Mr. B. C. Aston.

8. "The Interpretation of Milk Records," by Mr. B. C. Aston.

9. "Potassium in Agricultural Samples," by Mr. B. C. Aston.

10. "Notes on the Phanerogamic Flora of the Ruahine Mountain-chain," by Mr. B. C. Aston.

11. "Unconformities in the Stratified Rocks of the West Coast of the South Island," by Mr. P. G. Morgan.

12. "On the Relation of the Great Marlborough Conglomerate to the Underlying Formations in the Middle Clarence Valley," by Mr. C. A. Cotton.

13. "Preliminary Note on the Uplifted East Coast of Marlborough," by Mr. C. A. Cotton.

14. "Supplementary Notes on Wellington Physiography," by Mr. C. A. Cotton.

15. "The Geological History of the Westport–Charleston High-level Terraces," by J. A. Bartrum.

Exchanges.—Mr. C. A. Cotton moved, That the representatives of the Wellington Philosophical Society on the Board of Governors of the New Zealand Institute be requested to move in the matter of having more care taken of current periodicals, &c., received as exchanges, especially in the direction of making sure that all numbers are received, and that the complete set of numbers making each volume is carefully prepared for binding.

The motion was seconded by Mr. Bartrum, and supported by Professor Easterfield and Mr. Morgan, and carried.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

SPECIAL MEETING: *5th April, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and about 350 others.

Address.—"Other Worlds than Ours," by Miss Mary Proctor.

The address was illustrated by a large number of fine lantern-slides.

FIRST MEETING: *7th May, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and 250 members and friends.

The opening meeting of the session was held in the hall of Canterbury College, and partook of the nature of a conversazione, during which short addresses were delivered.

Addresses.—1. "New Zealand Birds," by Mr. Edgar F. Stead.
2. "Physical Experiments," by Dr. C. Coleridge Farr.
3. "Colour Photography," by Mr. S. Page.

Exhibits.—A number of exhibits were displayed in the hall.

SECOND MEETING: *4th June, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and sixty members and friends.

New Members.—Misses F. Berkeley, C. B. Mills, Messrs. G. E. Archey, A. C. Purchas, W. George Howes, W. H. Clark, and Dr. T. A. MacGibbon.

Papers.—1. "Some Photometric Measurements of the Dispersing-power of certain Commercial Glasses," by Mr. D. B. McLeod.
2. "On certain Tripolar Relations," by Mr. E. G. Hogg.

Address.—"The Origin of Taranaki Petroleum," by Mr. R. Speight.

Exhibits.—A number of exhibits were shown by Messrs. R. Nairn, C. Dash, E. Herring, and C. E. Foweraker.

THIRD MEETING: *2nd July, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and about fifty members and friends.

New Members.—Miss B. E. Baughan, Messrs. E. A. Belcher, H. Holland, J. J. Dougall, O. J. W. Napier, J. W. Bird.

Address.—Dr. L. Cockayne delivered his ex-presidential address on "A Suggestion for Future Research in Canterbury."

FOURTH MEETING: *6th August, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and about thirty members and friends.

New Members.—Dr. Fleming, Mr. Gilbert Anderson.

Papers.—1. "Observations on New Zealand Mistletoe," by Mr. C. E. Foweraker.
2. "A Species of *Daphnia* new to New Zealand," by Mr. G. E. Archey.
3. "Ecological Notes on the Forest of the Port Hills," by Miss L. A. Suckling; communicated by Dr. Chilton.

Exhibits.—1. Some New Zealand shipworms (*Teredo*), by Mr. H. Suter.
2. Some New Zealand fishes, by Mr. Edgar R. Waite.

FIFTH MEETING: *3rd September, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and about sixty members and friends.

Address.—"The Fossil Plants of the British Carboniferous," by Rev. J. Holloway.

Paper.—"Some Results of Glaciation of Lake Coleridge District," by Mr. R. Speight.

SIXTH MEETING: *1st October, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and about fifty members and friends.

Papers.—1. "The Subalpine Flora of Banks Peninsula," by Mr. R. M. Laing.
2. "Supplementary List of Fossils from the Lower Waipara Gorge," by Mr. R. Speight.
3. "List of Fossils from Bluecliffs, South Canterbury," by Mr. M. C. Gudex.
4. "The Relative Economy, Composition, and Nutritive Values of the Retail Cuts of Mutton and Lamb," by Mr. A. M. Wright.

Exhibit.—Some experiments in electric resonance, by Dr. C. Coleridge Farr.

Seventh Meeting: *5th November, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and about fifty members and friends.

Address.—"Industrial Applications of Electricity," by Mr. R. L. Gray.

Papers.—1. "Unrecorded Plant-habitats, No. IX," by Dr. L. Cockayne.

2. "Note on a Dredging off Puysegur Point," by Mr. P. Chapman; communicated by Dr. Chilton.

This material consists largely of quartz sand with broken and water-worn shells, *Polyzoa*, and Echinoid spines. It indicates an area in which there is a continual scour by currents or tidal action, and therefore affords little chance of finding many perfect organisms. It resembles, in fact, a beach sand such as occurs on a rocky coast unrelieved by stretches of mud deposits.

The organisms noted are,—

Foraminifera—

Miliolina seminulum Linné sp. Very rare.
—— *polygona* d'Orbigny sp. Very rare.
Spiroplecta sagittula Defrance sp. Very rare.
Polymorphina elegantissima Parker and Jones. Common.
—— *compressa* d'Orbigny. Very rare.
Pulvinulina repanda Fichtel and Moll sp. Very rare.
—— —— var. *concamerata* Montagu var. Very rare.
Rotalia clathrata Brady. Occasional.

All the above species have been previously recorded from the Subantarctic Islands of New Zealand (see my report, Subantarctic Islands of N.Z., 1909, pp. 366–70).

Echinoid spines, fairly abundant; indeterminate.

Polyzoa—

Crisia sp., *Idmonea* sp., *Cellaria* sp., *Cellepora* sp., *Selenaria* sp.

Mollusca—

Cuna sp., *Philobrya* sp., *Liotia* sp., *Cyclostrema* sp.

The muds from Milford Sound and Charles Sound were both barren of organisms, being purely terrigenous in character.

Mr. N. Benporath has kindly assisted me in searching the above material for *Foraminifera.*

Annual Meeting: *3rd December, 1913.*

Present: Dr. Charles Chilton, President, in the chair, and sixteen members and friends.

New Member.—Mr. Guy Brittin.

Annual Report.—The annual report and balance-sheet for the year were adopted.

Abstract.

Meetings of the Institute.—Nine meetings of the Institute have been held during the year, at which the following addresses were delivered: "A Suggestion for Future Research in Canterbury," ex-presidential address by Dr. L. Cockayne; "Other Worlds than Ours," by Miss Mary Proctor; "The Origin of Taranaki Petroleum," by Mr. R. Speight; "The Fossils of the British Carboniferous," by Rev. J. Holloway; "Industrial Applications of Electricity," by Mr. R. L. Gray.

At the regular meetings sixteen papers embodying the results of original research have been read. These may be classified as follows: Botany, 6; chemistry, 1; geology, 4; mathematics, 1; physics, 1; zoology, 3.

The Council has had before it the suggestion for future research in Canterbury, outlined by Dr. L. Cockayne in his ex-presidential address, and, while recognizing that the Institute should undertake definite work of the character outlined, it was decided, after full consideration, that in the meantime the Council could not commit the Institute to any definite scheme.

Membership.—During the year fifteen new members have been elected, and twelve have either resigned or have been struck off, so that the number now stands at 178. The Council regrets to record the loss by death of Messrs. J. D. Enys and J. L. Scott, both of whom have been associated with this Institute for many years.

Antarctic Expedition.—Having been so intimately associated with Antarctic research, the Council learned with grief the sad news of the loss of Captain Scott, Dr. Wilson, and their companions in the sledging party from the South Pole. At a meeting held on the 11th February the Council placed on record its admiration for the great achievements in Antarctic exploration of Captain Scott and his associates, and conveyed to the families and relatives of those who had perished its deepest sympathy with them in their sorrow. At the suggestion of the Council, the Mayor of Christchurch convened a general meeting for the purpose of considering the establishment of a suitable memorial. It is gratifying to note that as a result a large sum of money has now been subscribed, and it is hoped that a memorial suitably commemorating the heroic deeds will shortly be erected.

British Association Meeting.—The Council desires to call attention to the meeting of the British Association in Australia in 1914, and hopes that a number who have been invited will extend their visit to New Zealand. According to the suggested programme, meetings are to be held in Wellington and Christchurch early in September. As the visit of these men will naturally stimulate local scientific work, a hearty welcome will be extended by the incoming Council to our visitors.

Obituary.—The Council feels that through the death of Mr. A. Hamilton, Director of the Dominion Museum and a past President of the New Zealand Institute, the cause of scientific endeavour in this land has lost a valued contributor, especially in the departments of ethnology and New Zealand bibliography. At a meeting on the 5th November the Institute expressed its sorrow and its sense of the loss sustained through his death.

The Council also notes with deep regret the death of the veteran naturalist Alfred Russel Wallace, O.M., F.R.S., an honorary member of the New Zealand Institute, the co-discoverer with Darwin of the theory of Natural Selection. His researches in the geographical distribution of plants and animals have a special bearing on the problems of the origin of New Zealand flora and fauna, and have greatly stimulated research on the subject by New Zealand workers.

Science and Art Bill.—A Bill dealing with the Dominion Museum, Art Gallery, and the New Zealand Institute was introduced into Parliament, and the Council, in considering this Bill, took exception to the clauses referring to the representation of the New Zealand Institute on the Board established under the Bill. The Council also objected strongly to the sections relating to the publication and sale of the Transactions. It is noted with satisfaction that the clauses objected to have been deleted from the Bill, while recent information has been received that the sum of £250 has been placed on the estimates for the current year as an additional grant, in order to enable the Institute to publish the Transactions.

Arthur's Pass Tunnel Investigation.—During the past year the usual temperature observations were continued, and specimens of the rocks have been received for examination, in order to keep the series complete, but owing to the slow progress of the work no special results can yet be recorded.

Protection of the Fur Seal.—At the instance of the Otago Institute, the Council has written to the Minister of Marine, protesting against the removal of the protection hitherto accorded the fur seal. In addition, the attention of the Minister was called to the fact that the seals have been killed in the Sounds National Park. It is hoped that these representations will result in the renewal of the protection of the fur seals, otherwise this species will soon be quite exterminated.

Library.—The efficiency of the library has been fully maintained, and the calls upon the available space have necessitated increased shelving being provided.

Antarctic Library.—The Council has kept the needs of this section well in view, and has purchased to the full extent of its available resources, the publications of the Deutsche Süd-Polar Expedition alone having absorbed a large sum. It is hoped that the publications of the "Belgica" Expedition may be obtained in the near future; but these also are expensive productions.

The Institute is most grateful to the French Government for presenting the publications of the two recent south polar expeditions under Dr. Charcot, and to Dr. Chilton, President of the Institute, for supplying various Antarctic works.

The Council was pleased to place the library at the disposal of the members of the British Antarctic Expedition under the late Captain Scott, and gratified to know that the privilege extended was largely availed of and appreciated by several members of the ill-fated expedition.

Balance-sheet.—The balance-sheet shows that the total receipts for the year, including members' subscriptions and sale of publications, amount to £179 8s.

In order to make the final payment to the Government Printer for printing the "Subantarctic Islands of New Zealand," it has been necessary to transfer to the General Account the accrued interest on the life members' subscription account—viz., £71 18s. 9d. It is satisfactory to note that the liability on account of the "Subantarctic Islands of New Zealand," amounting in the beginning to £700, has now been liquidated. The total expenditure for the year amounted to £356 8s. 7d., and there is a credit balance at the Bank of New Zealand of £69 2s. 9d. The principal liabilities are an amount of £35 for periodicals from Dulau and Co., London, and the balance of the Tunnel Investigation Account, amounting to £140 6s. 11d.

Papers.—1. "An Ecological Study of some New Zealand Sand-dune Plants," by Miss Pegg; communicated by Dr. Chilton.

2. "Some Species of New Zealand Flowering-plants," by Dr. L. Cockayne.

3. "Notes on New Zealand Fishes, No. 4," by Mr. Edgar R. Waite.

4. "Note on a Collection of Rocks from White Island," by Mr. R. Speight.

5. "Description of New Zealand *Lepidoptera*," by Mr. E. Meyrick; communicated by Dr. Chilton.

Election of Officers for 1914.—The following were elected officers: *President*—Dr. W. P. Evans; *Vice-Presidents*—Dr. Charles Chilton, Mr. P. H. Powell; *Hon. Secretary*—Mr. A. M. Wright; *Hon. Treasurer*—Mr. R. Speight; *Hon. Librarian*—Mr. Edgar R. Waite; *Council*—Dr. C. Coleridge Farr, Dr. L. Cockayne, Mr. L. Birks, Dr. F. W. Hilgendorf, Dr. S. Page, Mr. R. M. Laing; *Hon. Auditor*—Mr. G. E. Way, F.P.A.N.Z.

OTAGO INSTITUTE.

FIRST MEETING: *6th May, 1913.*

The President, Professor J. Malcolm, in the chair.

New Member.—Mr. E. F. Green.

Address.—The President delivered his presidential address, entitled "A Review of the Position of Scientific Research in New Zealand.

SECOND MEETING: *10th June, 1913.*

The President, Dr. J. Malcolm, in the chair.

New Members.—Dr. E. J. O'Neill, and Messrs. H. I. M. Ross and G. Turner.

Exhibit.—Dr. Benham, in exhibiting a fine specimen of a red kaka which had recently been shot on Stewart Island, and which had ultimately come into his possession by permission of the Minister of Internal Affairs, commented upon the fact that not only the general public, but apparently the police authorities also, were ignorant of the protection accorded to kakas and other native birds, especially upon Stewart Island.

Papers.—1. "Modern Alchemy and Radio-active Change," by Dr. J. K. H. Inglis.

A summary and explanation of the most recent work of Ramsay and Soddy, and Collie and Paterson.

2. "Evolution of Maori Art," by Mr. H. D. Skinner.

THIRD MEETING: *1st July, 1913.*

Dr. W. B. Benham, F.R.S., Vice-President, in the chair.

New Members.—Mr. H. E. Hart and Professor D. J. Richards.

Address.—"Stewart Island," by Mr. D. L. Poppelwell.

An extremely interesting popular lecture, illustrated by some eighty lantern-slides. The speaker dealt briefly with the history of the island, its association with the old whaling industry, and its configuration and geographical features, but more particularly with its fauna and flora and its many scenic attractions.

FOURTH MEETING: *5th August, 1913.*

The President, Dr. J. Malcolm, in the chair.

New Member.—Mr. E. H. Drew.

Address.—"Light," by Mr. E. E. Stark.

The address was illustrated by a large number of demonstrations with special apparatus.

FIFTH MEETING : *2nd September*, 1913.

The President, Dr. J. Malcolm, in the chair.

Protection of Fur Seal.—On the motion of Dr. Benham, a resolution was adopted deploring the removal of the protection hitherto accorded to the fur seal in the waters of the Dominion, and asking the Minister to restore the protection at an early date, before the number of the seals is diminished beyond recovery.

Paper.—" The Common Infectious Diseases," by Dr. S. T. Champtaloup.

The latter portion of the paper dealt with chicken-pox and smallpox, the nature of the epidemic raging at the time in Auckland, and the efficiency of vaccination as a preventive.

SIXTH MEETING : *7th October, 1913.*

The President, Dr. J. Malcolm, in the chair.

New Member.—Mr. J. W. Williamson.

Exhibits.—Dr. Benham exhibited—(1) cast of the jaw of a marsupial from the Jurassic deposits of Oxfordshire ; (2) cast of a very large footprint of moa from Manawatu district ; (3) very large specimens of vegetable caterpillars from Tokonui Gorge.

Dr. Inglis exhibited an improved form of mercury vacuum pump.

Papers.—1. " Some Observations on Tutin and Tutu Poisoning," by Dr. Malcolm.

2. " Notes on the Distribution of *Diptera,*" by Mr. D. Miller.

3. " The Revised Nomenclature of New Zealand Birds," by Dr. Benham, F.R.S.

4. " Notes on New Zealand Birds," by Mr. A. Philpott ; communicated by Dr. Benham.

5. " Descriptions of New Species of *Lepidoptera,*" by Mr. A. Philpott ; communicated by Dr. Benham.

6. " List of Phanerogamic Plants indigenous to the Southland District," by Mr. J. C. Smith, F.L.S.

7. " Classified List of New Zealand *Rotatoria,*" by Mr. C. B. Morris, F.R.M.S.

8. " Notes on the Botany of Routeburn Valley and Lake Harris Saddle," by Mr. D. L. Poppelwell.

9. " On the Pigment of the New Zealand Oyster," by Mr. G. H. Robertson ; communicated by Dr. Malcolm.

SEVENTH MEETING : *4th November, 1913.*

The President, Dr. J. Malcolm, in the chair.

New Member.—Mr. H. Mandeno.

Papers.—1. " New *Lepidoptera,*" by Mr. L. B. Prout, F.E.S. ; communicated by Mr. W. G. Howes.

2. " New *Lepidoptera,* ' by Mr. W. G. Howes, F.E.S., F.L.S.

3. " Notes on Entomology of Stewart Island," by Mr. W. G. Howes.

4. " Notes on Life-history of some New Zealand Moths," by Mr. W. G. Howes.

5. "The Geology of Komiti Bluff, Kaipara Harbour, and of Orewa," by Dr. P. Marshall, F.G.S.

6. "Notes on the Geology of the Islands Moorea and Rurutu," by Dr. P. Marshall, F.G.S.

Address.—"Old Clocks and Watches," by Mr. F. W. Payne.

An interesting history of clock and watch making, with many exhibits of fine specimens of the watchmaker's art dating back as far as the early part of the eighteenth century.

EIGHTH MEETING: *2nd December, 1913.*

The President, Dr. J. Malcolm, in the chair.

New Members.—Messrs. James Edgar and J. T. Johnson.

Papers.—1. "Localities for Fossils near Oamaru," by Professor P. Marshall, D.Sc., F.G.S., and Mr. G. H. Uttley, M.Sc., F.G.S.

2. "Geology of the Cape Runaway District," by Professor P. Marshall, D.Sc., F.G.S.

3. "On the Relationship of the Tertiary and Cretaceous Strata of North Auckland," by Professor James Park, F.G.S.

Annual Report.—The annual report and the balance-sheet for 1913 were read and adopted.

ABSTRACT OF ANNUAL REPORT.

Work of the Council.—During the year the Council has met eight times for the transaction of the business of the Institute.

On the introduction of the Science and Art Bill, 1913, into the Lower House, strong exception was taken by your Council to certain of its provisions, and resolutions were forwarded to the Minister in charge of the Bill, and to the New Zealand Institute, protesting against the small representation of the New Zealand Institute on the proposed Board of Science and Art, and objecting to the proposal that the Board of Science should decide upon the suitability of papers for publication in the Transactions after they had been passed by the Board of Governors of the New Zealand Institute. It is satisfactory to note that the clauses that called forth these protests were removed from the Bill before it was finally passed.

Acting upon reliable information that indiscriminate slaughter of native birds was taking place on Stewart Island, in spite of the fact that the greater part of it has been proclaimed a sanctuary for bird-life, the Council approached the Government with a view to obtaining a more effective enforcement of protection for the native birds on the island, either by appointing rangers or otherwise. It is gratifying to note that the Southland Acclimatization Society, to whom the Minister also referred the matter, has undertaken to co-operate by appointing rangers, and by placing warning notices in various localities on the island.

Meetings.—Eight meetings of the Institute have been held during the session, at which there have been read or received eighteen papers embodying the results of original work. These may be classified as follows: Entomology, 7; ornithology, 2; botany, 2; chemistry, 1; geology, 5; physiology, 1.

Of more general interest to members were the following addresses: "A Review of the Position of Scientific Research in New Zealand" (presidential address), by Professor Malcolm; "Modern Alchemy and Radio-active Change," by Professor J. K. H. Inglis, D.Sc.; "The Evolution of Maori Art," by Mr. H. D. Skinner, B.A.; "Stewart Island" (lantern lecture), by Mr. D. L. Poppelwell; "Light," by Mr. E. E. Stark; "The Common Infectious Diseases," by Dr. S. T. Champtaloup.

Fur Seals.—At its September meeting the Institute passed a resolution, addressed to the Minister of Marine, deploring the removal of the protection hitherto accorded to the fur seal in New Zealand waters, and praying that that animal should, in the interests of science, be saved from extinction by the restoration of the protection at an early date. The Minister replied that inquiry would be made as to the effect of the present open season before a decision was arrived at next year.

The late Mr. A. Hamilton.—During the year there has passed away, in the person of Mr. A. Hamilton, Director of the Dominion Museum, Wellington, one of the most active workers in scientific research in this country. Mr. Hamilton at different times acted as President, Secretary, and member of the Council of this Institute, and at the time of his death he was a life member. The Institute has placed on record its keen sense of regret at Mr. Hamilton's loss, and its appreciation of his valuable work in connection with the fauna and the ethnology of the Dominion.

Technological Branch.—The work of this branch for the past year may be considered to have been quite satisfactory. Six new members were introduced, and the resignations of four were accepted.

The following lectures were delivered during the session: Mr. L. O. Beal—"Coal-mining Operations"; Captain S. G. Sandle—"The Evolution of Artillery"; Mr. G. W. Davies—"Modern Methods of Heating Buildings"; Mr. J. H. Scott—"Mechanical Refrigeration"; Mr. F. W. Payne—"Notes on Centrifugal Pumps"; Professor Waters—"The Cyanide Process"; Mr. R. N. Vanes—"Design, from a Technical Standpoint;" Mr. J. Blair Mason—"Improvement Works in Otago Harbour."

The average attendance at meetings works out slightly over twenty-two.

Astronomical Branch.—Your Committee begs to report that for the first time since the inception of this branch a syllabus of lectures was arranged for the year, and has been carried out, all meetings having been well attended.

The following papers were read: "The History of Astronomical Research," Mr. Gilkison; "Reflecting Telescopes," Mr. Payne; "Objects of Interest in the Evening Sky in the Month of June, 1913," Rev. D. Dutton, F.R.A.S.; "New Instruments and Methods in Solar Research," Rev. P. W. Fairclough, F.R.A.S.; "On finding Latitude and Longitude," Dr. Cameron; "Methods of observing to eliminate the Periodic Errors affecting the Readings of the Graduated Circles in Astronomical and Surveying Instruments," Mr. W. T. Neill. Besides these lectures, the branch was fortunate in securing an address from the Rev. T. Roseby, LL.D., F.R.A.S., of Sydney. A lecture by Miss Mary Proctor was given in aid of a solar physics observatory on the 31st March, 1913, under the auspices of this branch, on "The Southern Cross and other Wonders of the Skies." The net profit was £9 4s., from which £4 4s. was handed over to Miss Proctor as per agreement, and £5 was paid to the Observatory Fund with the Public Trustee. As the whole of the necessary funds for the observatory have since been provided by Mr. Cawthron, of Nelson, no doubt some application in the matter will be made henceforth to this society by the Public Trustee.

Your Committee has erected during the year the small observatory on Tanna Hill, in which are fitted up the Skey telescope (10 in.) and the Beverley telescope (3 in.). The total cost of the building, including foundations, fences, &c., was £125 1s. 1d., which has used up all the accumulated funds of the branch. By arrangement, the Institute allows this branch £20 per annum for ordinary expenses.

A commencement has been made with forming an astronomical library. One work, Webb's "Celestial Objects for Common Telescopes," was presented by Mr. T. J. Walker, and a number of works were ordered by the Institute Council. These will form part of the Institute's fine library, now kept at the Museum.

The branch is much indebted to Mr. F. W. Payne for the plans of the observatory and supervising the erection of the same, as well as his constant attention to the instruments. It also owes a vote of thanks to its energetic Secretary, Mr. Megget, for his unflagging efforts on its behalf.

Membership.—During the year twelve new members have been elected, six of whom belonged to the Technological and two to the Astronomical Branch. On the other hand, thirty-seven members have resigned or have been struck off, owing chiefly to removals from the Dominion, and three members—Messrs. Michael Elliot, Augustus Hamilton, and J. M. Ritchie—have been removed by death. The membership roll, therefore, has suffered a net decrease of twenty-eight, and now stands at 226.

Librarian's Report.—At the request of the Astronomical Branch, seven books on astronomy have been purchased, and a journal subscribed to. Some of these are popular in style; others are of a technical nature, more suitable for students of the subject.

All the astronomical works have been placed on a shelf, specially labelled, near the door.

The Institute has to acknowledge the gift by the Hocken Library trustees of a copy of the "Catalogue of the Hocken Library," compiled by Mr. W. H. Trimble.

Two new periodicals have been subscribed for—namely, "Bedrock," a journal dealing in a rather popular fashion with current scientific problems of all kinds, and the "Journal of the British Astronomical Association."

Balance-sheet.—The balance-sheet, presented by the Treasurer (Mr. R. N. Vanes), showed a credit of £137 17s. 2d. The receipts totalled £721, including subscriptions amounting to £200, deposits at call amounting to £450.

Election of Officers for 1914.—President—Mr. F. W. Payne; *Vice-Presidents*—Dr. J. Malcolm and Mr. R. Gilkison; *Hon. Secretary*—Mr. E. J. Parr; *Hon. Treasurer*—Mr. R. N. Vanes; *Hon. Auditor*—Mr. D. Brent; *Hon. Librarian*—Dr. W. B. Benham; *Council*—Dr. W. B. Benham, Dr. P. D. Cameron, Dr. R. V. Fulton, Dr. P. Marshall, Professor J. Park, Messrs. H. Brasch and G. M. Thomson, M.P. Mr. G. M. Thomson and Dr. P. Marshall were re-elected representatives of the Institute on the Board of Governors of the New Zealand Institute.

TECHNOLOGICAL BRANCH.

First Meeting: *20th May, 1913.*

Mr. F. W. Payne, Vice-Chairman, in the chair.

Address.—"Coal-mining Operations," by Mr. L. O. Beal.

Second Meeting: *17th June, 1913.*

Mr. E. E. Stark in the chair.

Address.—"The Evolution of Artillery," by Captain S. G. Sandle.

Third Meeting: *15th July, 1913.*

Mr. G. Simpson, Vice-Chairman, in the chair.

Address.—"Modern Methods of Heating Buildings," by Mr. G. W. Davies.

An interesting lecture covering the origin and development of the various systems of heating buildings, and illustrated by a large number of slides. The lecturer emphasized the inefficiency and wastefulness of the ordinary open-fire system.

Fourth Meeting: *19th August, 1913.*

Mr. E. E. Stark in the chair.

Address.—"Mechanical Refrigeration," by Mr. J. H. Scott.

Fifth Meeting: *16th September, 1913.*

Mr. E. E. Stark in the chair.

Papers.—1. "Centrifugal Pumps," by Mr. F. W. Payne.
2. "The Cyanide Process," by Professor D. B. Waters, A.O.S.M.

SIXTH MEETING : *21st October, 1913.*

Mr. E. E. Stark in the chair.

Address.—"Design, from a Technical Standpoint," by Mr. R. N. Vanes, A.R.I.B.A.

SEVENTH MEETING : *18th November, 1913.*

Mr. E. E. Stark in the chair.

Address. — "Improvement Works in Otago Harbour," by Mr. J. B. Mason.

An interesting historical lecture by the Engineer of the Harbour Board, tracing the improvements made in the harbour since the first accurate survey by Captain Stokes, R.N., of H.M.S. "Acheron," in 1849. About fifty lantern-slides were shown, illustrating training-walls, groins, and other skilfully conceived devices for improving the harbour and its approaches.

EIGHTH MEETING : *16th December, 1913.*

Mr. E. E. Stark in the chair.

The annual report was read and adopted, and the following office-bearers for 1914 were elected : *Chairman*—Mr. E. E. Stark ; *Vice-Chairmen*—Professor Park and Mr. F. W. Payne ; *Hon. Secretary*—Mr. H. Brasch ; *Committee*—Professor Waters, Messrs. B. B. Hooper, J. B. Mason, W. D. R. McCurdie, C. F. McDonald, R. McLintock, and G. Simpson.

ASTRONOMICAL BRANCH.

FIRST MEETING : *27th May, 1913.*

Mr. R. Gilkison in the chair.

Papers.—1. "The History of Astronomical Research," by Mr. R. Gilkison.
2. "The Reflecting Telescope," by Mr. F. W. Payne.

SECOND MEETING : *24th June, 1913.*

Mr. R. Gilkison in the chair.

Address.—"Objects of Interest in the Evening Sky in the Month of June, 1913," by the Rev. D. Dutton, F.R.A.S.

THIRD MEETING : *22nd July, 1913.*

Mr. R. Gilkison in the chair.

Address.—"New Instruments and Methods in Solar Research," by the Rev. P. W. Fairclough, F.R.A.S.

FOURTH MEETING: *26th August, 1913.*

Mr. R. Gilkison in the chair.

Paper.—"On finding Latitude and Longitude," by Dr. P. D. Cameron.

FIFTH MEETING: *23rd September, 1913.*

Mr. R. Gilkison in the chair.

Papers.—1. "On Methods of observing to eliminate the Periodic Errors affecting the Readings of the Graduated Circles in Astronomical and Surveying Instruments," by Mr. W. T. Neill.

2. "Is Mars habitable?" by the Rev. D. Dutton, F.R.A.S.

The annual report was read and adopted, and the following office-bearers for 1914 were elected: *Chairman*—Mr. R. Gilkison; *Vice-Chairmen*—Professors J. Park and D. J. Richards and Mr. F. W. Payne; *Hon. Secretary*—Mr. A. Megget; *Committee*—Rev. D. Dutton, F.R.A.S., Rev. P. W. Fairclough, F.R.A.S., Dr. P. D. Cameron, Messrs. H. Brasch, J. Bremner, W. T. Neill, and W. S. Wilson.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

ABSTRACT OF ANNUAL REPORT.

During the year five meetings of the Institute were held, and the Council met seven times.

The following subjects were dealt with at the general meetings: "Alleged Disharmonies in Nature," by W. Kerr, M.A.; "Radio-telegraphy," by C. P. Eden, B.Sc.; "The Moa—Legendary, Historic, and Geological," by H. Hill, B.A., F.G.S.; "The Wireless System in Use in New Zealand," by C. P. Eden, B.Sc.; "Other Worlds than Ours," by Miss Proctor. As usual, the attendance at the meetings varied according to the interest of the subject, the hall being crowded at Miss Proctor's lecture.

Four new members were elected during the year, while seven names will be removed, two owing to death—those of Dr. Locking and Mr. A. Hamilton.

The library has been increased by the addition of nineteen volumes. Some of the books ordered during the year have not yet arrived, so that the list is smaller than it should be.

During the year an attempt was made by the New Zealand Institute to force up the subscription, but the Council was opposed to the idea. The result was that only half the expected number of volumes of the Transactions was sent for distribution among our members, and the volume was posted only to those who replied to a circular sent out regarding it. A few volumes are still available.

The Treasurer's statement shows a credit balance of £44 17s. 5d.

Election of Officers for 1913.—President—W. Dinwiddie; *Vice-President*—F. Hutchinson; *Council*—H. Hill, B.A., F.G.S., F. Heaton, M.A., B Sc., T. Hyde, T. C. Moore, M.D., D. Strachan, M.A., G. K. Sinclair; *Hon. Secretary*—J. Niven, M.A., M.Sc. (Technical College, Napier); *Hon. Treasurer*—W. Kerr, M.A. (Boys' High School, Napier); *Hon. Auditor*—J. S. Large; *Hon. Lanternist*—E. G. Loten.

MANAWATU PHILOSOPHICAL SOCIETY.

FIRST MEETING: *20th March, 1913.*

Paper.—"Some Scientists I have known," by Mr. W. Welsh, F.R.G.S.

The paper gave a brief sketch of the life and work of Professor Anderson Stuart, Dean of the Faculty of Medicine in Sydney University, and of Professor T. Edgeworth David, Professor of Geology in the same University. Special reference was made to the share of the latter in Sir E. Shackleton's Antarctic Expedition, and his location of the magnetic pole.

SECOND MEETING: *17th April, 1913.*

Lecture.—"The Wanganui River historically considered," by Mr. T. W. Downes, of Wanganui.

The lecture was illustrated by about sixty lantern-slides specially prepared by Mr. Downes for the purpose, and gave an account of various Maori myths associated with the river and its caves, and of the important part which it had played in the Maori wars.

THIRD MEETING: *25th April, 1913.*

Lecture.—"The Southern Cross and other Wonders of the Southern Skies," by Miss Proctor.

By arrangement, half the net proceeds of the lecture were given to the fund for the establishment of a solar physics observatory.

FOURTH MEETING: *2nd May, 1913.*

Paper.—"Reminiscences of Foreign Travel," by Mrs. J. H. Rimmer.

Describing local customs and peculiarities of the architecture, dress, and manners in Germany, Holland, Belgium, and France.

FIFTH MEETING: *23rd June, 1913.*

Mr. R. McNab, President, in the chair.

Lecture.—"The Alpine Region of Mid-Canterbury," by Mr. R. Speight, M.A., F.G.S., of Canterbury College.

SIXTH MEETING: *4th September, 1913.*

Mr. R. Gardner in the chair.

Lecture.—"The Spectroscope popularly explained," by Mr. J. W. Poynton, S.M.

Seventh Meeting: *30th October, 1913.*

Mr. R. Gardner in the chair.

Lecture.—"The Theory and Practice of the High-pressure Transmission of Power," by Mr. C. T. Salmon, Associate in Engineering.

Annual Meeting: *20th November, 1913.*

Mr. R. McNab, President, in the chair.

Annual Report.—The President moved the adoption of the report.

In doing so he mentioned that during his recent visit to Australia he had gained a large amount of additional information about the early history of New Zealand through the recent discovery in Sydney of the records—previously supposed to have been destroyed—of the Supreme Court of New South Wales from 1788 to 1830.

In speaking to the motion, several members suggested that the Government should give Mr. McNab some honorary official position that would give him the right of free access to all sources of information.

Abstract of Annual Report.

In presenting their annual report your Council have first to express their deep sense of the loss which the Society has sustained in the lamented death of Captain Hewitt, R.N., one of the original members of the Society, who ever since its establishment has been in charge of the observatory, in which he at all times took the keenest interest. Mr. C. T. Salmon has, at the request of the Council, kindly taken charge in his place.

During the year two members have died, six have resigned, two have been struck off for failing to pay their subscription, and four new members have been elected. There has thus been a decrease in the number of members; and, unfortunately, no increase in the contribution of papers or notes, or in the attendance at the ordinary meetings of the Society.

There have been held eleven meetings of the Council and eight general meetings, at which the following papers were read: "Scientists of Note," by Mr. Welsh, F.R.G.S.; "The Wanganui River historically considered," by Mr. T. W. Downes; "The Southern Cross and other Wonders of the Southern Skies," by Miss Proctor; "Reminiscences of Continental Travel," by Mrs. J. H. Rimmer; "The Alpine Regions of Mid-Canterbury," by Mr. R. Speight, M.A., F.G.S.; "The Spectroscope popularly explained," by Mr. J. W. Poynton, S.M.; "The Theory and Practice of the High-pressure Transmission of Power," by Mr. C. T. Salmon, Associate in Engineering; "The Flowers of the Sky," by Miss Proctor.

The Museum still continues to grow rapidly, there having been over 120 additions in the course of the year, among the most noticeable of which are—Human bones and cooking-stones from a Maori oven on the Mokau Beach, presented by Mr. McNab; various birds, native and Australian, obtained partly by purchase and partly by exchange with the Otago Museum; collections illustrating the processes of manufacture of linoleum, shale-oil, glue, paper, hooks and eyes, needles, pens, and explosives, these being obtained from the various manufacturers at Home, and forwarded by the kindness of Miss Glendinning.

Election of Officers for 1914.—President—Mr. J. W. Poynton, S.M.; *Vice-Presidents*—Messrs. R. McNab, M.A., LL.B., F.R.G.S., and R. Gardner; *Officer in charge of the Observatory*—Mr. C. T. Salmon, Associate in Engineering; *Council*—Messrs. J. L. Barnicoat, M. A. Eliott, J. B. Gerrand, W. Park, J. E. Vernon, M.A., and Miss Ironside, M.A.; *Secretary and Treasurer*—Mr. K. Wilson, M.A.; *Auditor*—Mr. R. Davis, F.P.A.N.Z.

WANGANUI PHILOSOPHICAL SOCIETY.

ANNUAL MEETING: *15th December, 1913.*

Dr. Hatherly, President, in the chair.

The annual report and balance-sheet was adopted.

The financial position was satisfactory, showing a balance on hand and in bank of £35 9s. 3d., after payment of a subsidy to the Museum of £21 11s. 2d.

ABSTRACT OF REPORT.

Membership.—The roll of the Society at date includes sixty-nine ordinary and sixty-three associate members.

Council.—The Council held three meetings during the year.

It was resolved to record in the minutes appreciation of the services to science of the late Mr. Augustus Hamilton, Curator of the Dominion Museum and ex-President of the New Zealand Institute. Mr. Hamilton, it will be remembered, came to Wanganui at the inauguration of this Society.

Mr. H. W. Hesse, the Society's representative on the Board of Governors of the New Zealand Institute, reported on the meetings of the Board held during the year.

It was agreed to adopt a resolution of the Otago Institute deploring the removal of the protection hitherto accorded to the fur seal, and asking the Minister of Marine to restore the protection at an early date, before the number is diminished beyond recovery. This resolution was communicated to the Minister of Marine, who has replied that "inquiries are now being made as to the effect of the recent open season, and if it is found that the numbers of the seals have been so reduced as to render it necessary that the open season should be done away with until there has been a substantial increase the close season will be extended."

During the year the Society sustained loss through the death of the Rev. J. Ross and of Mr. J. T. Stewart, both members keenly interested in its welfare and progress.

Meetings.—The following papers were read at meetings of the Society: Mr. Walter Grey—"The Worker's Attitude towards Immigration"; Mr. C. J. Wray—"Unemployment in England"; Mr. A. D. Brodie, LL.B.—"Objects of Local Historical Research Committee of the Society"; Professor C. W. von Zedlitz, M.A.—"Dante"; Mr. T. W. Downes—"The Wanganui River from an Historical Standpoint"; Mr. G. D. Braik, M.A.—"What is Technical Education?"; Rev. J. Ll. Dove, M.A.—"The Permanence of the Trade Routes of Europe"; Mr. Morris N. Watt—"Notes on the Eggs of some New Zealand Moths"; Mr. E. H. Clark—"The Theory of Harmonics"; Sir Robert Stout, K.C.M.G.—"The New-Zealander of the Future"; Mr. J. T. Ward—"Evolutionary Facts and Factors in the Origin of Life, with Special Reference to Professor Schaefer's Dundee Address."

Under the joint auspices of the Society and the Wanganui Astronomical Society, two lectures on astronomical subjects were delivered by Miss Mary Proctor in aid of the establishment in New Zealand of a solar physics observatory, a result fortunately assured through the generous donation of £12,000 by Mr. Cawthron.

On the invitation of the Savage Club, the members had the opportunity of enjoying a beautifully illustrated lecture, by Mr. C. R. Ford, on "Antarctica."

Paper.—A paper was contributed by Mr. H. E. Sturge, B.A., advocating the formation of subsections for special study.

This, he held, would increase the value of the Society to the community, by stimulating the members to individual effort, and by making it a factory of educated opinion. At present, papers if popular represented an evening's amusement, and if technical were practically useless to the members, serving mainly to enable expert to communicate with expert by means of the printed Transactions. He suggested the establishment of small groups—say, from six to twelve—from our members and associates for

reading or investigating along certain lines, the members of each group to meet regularly and follow a programme arranged by themselves, possibly on co-operative lines. An annual summary of their work might be submitted to the Society.

Considerable discussion resulted, and eventually a committee was set up to go into the matter.

Election of Officers for 1914.—President—Dr. H. R. Hatherly, M.R.C.S.; *Vice-Presidents*—Rev. J. Ll. Dove, M.A., and Mr. J. T. Ward; *Council*—Messrs. T. Allison, T. W. Downes, H. W. Hesse, M.A., B.Sc., F.L.S., R. Murdoch, H. B. Watson, M.A., W. A. Armour, M.A., M.Sc., C. T. Brown, M.A., LL.B., and H. E. Sturge, B.A.; *Hon. Treasurer*—W. F. P. Talboys; *Hon. Secretary*—Mr. J. P. Williamson; *Hon. Auditor*—Mr. H. S. G. Harper; *Representative on Board of Governors, New Zealand Institute*—Dr. H. R. Hatherly, M.R.C.S.

NELSON INSTITUTE.

Report of the Scientific and Literary Branch.

When in consequence of the fire the Nelson Institute had to seek refuge in temporary quarters, the Scientific Branch fell into a moribund condition; but as soon as the new building was erected it was decided to resuscitate the branch and resume the practice of holding meetings. A preliminary meeting was held on Monday, the 19th May, 1913, for the purpose of electing officers and deciding upon a programme of work. At four subsequent meetings interesting addresses were given as follows: 16th June, "Early Nelson," by Mr. T. H. Field; 21st July, "Fifty Years' Experience on the Collingwood Goldfields," by Mr. H. P. Washbourn; 30th September, "The Natural History of New Zealand," by Mr. H. Travers; 25th November, "Wireless Telegraphy," by Mr. L. J. Carmine.

A lecture was also given by Miss Proctor on the 14th April, at the School of Music, under the auspices of the Nelson Institute. How Miss Proctor's visit to Nelson resulted in Mr. Cawthron's offer to establish an observatory in the vicinity of Nelson is now a matter of history. We may confidently hope that the exceptional advantages which our clear skies offer for astronomical research will enable the Cawthron Observatory to make both itself and the Town of Nelson well known throughout the world.

The Atkinson Observatory, in Alton Street, has again been under the care of Mr. L. Morley, and has been visited by a fair number of the general public.

APPENDIX.

NEW ZEALAND INSTITUTE ACTS.

NEW ZEALAND INSTITUTE ACT, 1903.

The following Act reconstituting the Institute was passed by Parliament :—

1903, No. 48.

An Act to reconstitute the New Zealand Institute.

[*18th November, 1903.*

Whereas it is desirable to reconstitute the New Zealand Institute with a view to connecting it more closely with the affiliated institutions :

Be it therefore enacted by the General Assembly of New Zealand in Parliament assembled, and by the authority of the same, as follows :—

1. The Short Title of this Act is the New Zealand Institute Act, 1903.

2. The New Zealand Institute Act, 1867, is hereby repealed.

3. (1.) The body hitherto known as the New Zealand Institute (hereinafter referred to as "the Institute") shall consist of the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, the Otago Institute, the Hawke's Bay Philosophical Institute, the Nelson Institute, the Westland Institute, the Southland Institute, and such others as may hereafter be incorporated in accordance with regulations to be made by the Board of Governors as hereinafter mentioned.

(2.) Members of the above-named incorporated societies shall be *ipso facto* members of the Institute.

4. The control and management of the Institute shall be in the hands of a Board of Governors, constituted as follows :—

The Governor ;

The Colonial Secretary ;

Four members to be appointed by the Governor in Council during the month of December, one thousand nine hundred and three, and two members to be similarly appointed during the month of December in every succeeding year ;

Two members to be appointed by each of the incorporated societies at Auckland, Wellington, Christchurch, and Dunedin during the month of December in each alternate year ;

One member to be appointed by each of the other incorporated societies during the month of December in each alternate year.

5. (1.) Of the members appointed by the Governor in Council two shall retire annually on the appointment of their successors ; the first two members to retire shall be decided by lot, and thereafter the two memebrs longest in office without reappointment shall retire.

(2.) Subject to the provisions of the last preceding subsection, the appointed members of the Board shall hold office until the appointment of their successors.

6. The Board of Governors as above constituted shall be a body corporate, by the name of the "New Zealand Institute," and by that name they shall have perpetual succession and a common seal, and may sue and be sued, and shall have power and authority to take, purchase, and hold lands for the purposes hereinafter mentioned.

7. (1.) The Board of Governors shall have power to appoint a fit person, to be known as the "President," to superintend and carry out all necessary work in connection with the affairs of the Institute, and to provide him with such further assistance as may be required.

(2.) It shall also appoint the President or some other fit person to be editor of the Transactions of the Institute, and may appoint a committee to assist him in the work of editing the same.

(3.) It shall have power to make regulations under which societies may become incorporated to the Institute, and to declare that any incorporated society shall cease to be incorporated if such regulations are not complied with, and such regulations on being published in the *Gazette* shall have the force of law.

(4.) The Board may receive any grants, bequests, or gifts of books or specimens of any kind whatsoever for the use of the Institute, and dispose of them as it thinks fit.

(5.) The Board shall have control of the property hereinafter vested in it, and of any additions hereafter made thereto, and shall make regulations for the management of the same, for the encouragement of research by the members of the Institute, and in all matters, specified or unspecified, shall have power to act for and on behalf of the Institute.

8. Any casual vacancy on the Board of Governors, howsoever caused, shall be filled within three months by the society or authority that appointed the member whose place has become vacant, and if not filled within that time the vacancy shall be filled by the Board of Governors.

9. (1.) The first annual meeting of the Board of Governors hereinbefore constituted shall be held at Wellington on some day in the month of January, one thousand nine hundred and four, to be fixed by the Governor, and annual meetings of the Board shall be regularly held thereafter during the month of January in each year, the date and place of such annual meeting to be fixed at the previous annual meeting.

(2.) The Board of Governors may meet during the year at such other times and places as it deems necessary.

(3.) At each annual meeting the President shall present to the meeting a report of the work of the Institute for the year preceding, and a balance-sheet, duly audited, of all sums received and paid on behalf of the Institute.

10. The Board of Governors may from time to time, as it sees fit, make arrangements for the holding of general meetings of members of the Institute, at times and places to be arranged, for the reading of scientific papers, the delivery of lectures, and for the general promotion of science in the colony by any means that may appear desirable.

11. The Colonial Treasurer shall, without further appropriation than this Act, pay to the Board of Governors the annual sum of five hundred pounds, to be applied in or towards payment of the general current expenses of the Institute.

12. (1.) On the appointment of the first Board of Governors under this Act the Board of Governors constituted under the Act hereby repealed shall cease to exist, and the property then vested in, or belonging to, or under the control of that Board shall be vested in His Majesty for the use and benefit of the public.

(2.) On the recommendation of the President of the Institute the Governor may at any time hereinafter, by Order in Council, declare that any part of such property specified in the Order shall be vested in the Board constituted under this Act.*

13. All regulations, together with a copy of the Transactions of the Institute, shall be laid upon the table of both Houses of Parliament within twenty days after the meeting thereof.

NEW ZEALAND INSTITUTE ACT, 1908.

1908, No. 130.

An Act to consolidate certain Enactments of the General Assembly relating to the New Zealand Institute.

Be it enacted by the General Assembly of New Zealand in Parliament assembled, and by the authority of the same, as follows:—

1. (1.) The Short Title of this Act is the New Zealand Institute Act, 1908.

(2.) This Act is a consolidation of the enactments mentioned in the Schedule hereto, and with respect to those enactments the following provisions shall apply:—

(*a.*) The Institute and Board respectively constituted under those enactments, and subsisting on the coming into operation of this Act, shall be deemed to be the same Institute and Board respectively constituted under this Act without any change of constitution or corporate entity or otherwise; and the members thereof in office on the coming into operation of this Act shall continue in office until their successors under this Act come into office.

(*b.*) All Orders in Council, regulations, appointments, societies incorporated with the Institute, and generally all acts of authority which originated under the said enactments or any enactment thereby repealed, and are subsisting or in force on the coming into operation of this Act, shall enure for the purposes of this Act as fully and effectually as if they had originated under the corresponding provisions of this Act, and accordingly shall, where necessary, be deemed to have so originated.

(*c.*) All property vested in the Board constituted as aforesaid shall be deemed to be vested in the Board established and recognized by this Act.

(*d.*) All matters and proceedings commenced under the said enactments, and pending or in progress on the coming into operation of this Act, may be continued, completed, and enforced under this Act.

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* See *New Zealand Gazette*, 1st September, 1904.

2. (1.) The body now known as the New Zealand Institute (hereinafter referred to as "the Institute") shall consist of the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, the Otago Institute, the Hawke's Bay Philosophical Institute, the Nelson Institute, the Westland Institute, the Southland Institute, and such others as heretofore have been or may hereafter be incorporated therewith in accordance with regulations heretofore made or hereafter to be made by the Board of Governors.

(2.) Members of the above-named incorporated societies shall be *ipso facto* members of the Institute.

3. The control and management of the Institute shall be vested in a Board of Governors (hereinafter referred to as "the Board"), constituted as follows:—

The Governor:

The Minister of Internal Affairs:

Four members to be appointed by the Governor in Council, of whom two shall be appointed during the month of December in every year:

Two members to be appointed by each of the incorporated societies at Auckland, Wellington, Christchurch, and Dunedin during the month of December in each alternate year; and the next year in which such an appointment shall be made is the year one thousand nine hundred and nine:

One member to be appointed by each of the other incorporated societies during the month of December in each alternate year; and the next year in which such an appointment shall be made is the year one thousand nine hundred and nine.

4. (1.) Of the members appointed by the Governor in Council, the two members longest in office without reappointment shall retire annually on the appointment of their successors.

(2.) Subject to the last preceding subsection, the appointed members of the Board shall hold office until the appointment of their successors.

5. The Board shall be a body corporate by the name of the "New Zealand Institute," and by that name shall have perpetual succession and a common seal, and may sue and be sued, and shall have power and authority to take, purchase, and hold lands for the purposes hereinafter mentioned.

6. (1.) The Board shall have power to appoint a fit person, to be known as the "President," to superintend and carry out all necessary work in connection with the affairs of the Institute, and to provide him with such further assistance as may be required.

(2.) The Board shall also appoint the President or some other fit person to be editor of the Transactions of the Institute, and may appoint a committee to assist him in the work of editing the same.

(3.) The Board shall have power from time to time to make regulations under which societies may become incorporated with the Institute, and to declare that any incorporated society shall cease to be incorporated if such regulations are not complied with; and such regulations on being published in the *Gazette* shall have the force of law.

(4.) The Board may receive any grants, bequests, or gifts of books or specimens of any kind whatsoever for the use of the Institute, and dispose of them as it thinks fit.

(5.) The Board shall have control of the property from time to time vested in it or acquired by it; and shall make regulations for the

management of the same, and for the encouragement of research by the members of the Institute; and in all matters, specified or unspecified, shall have power to act for and on behalf of the Institute.

7. (1.) Any casual vacancy in the Board, howsoever caused, shall be filled within three months by the society or authority that appointed the member whose place has become vacant, and if not filled within that time the vacancy shall be filled by the Board.

(2.) Any person appointed to fill a casual vacancy shall only hold office for such period as his predecessor would have held office under this Act.

8. (1.) Annual meetings of the Board shall be held in the month of January in each year, the date and place of such annual meeting to be fixed at the previous annual meeting.

(2.) The Board may meet during the year at such other times and places as it deems necessary.

(3.) At each annual meeting the President shall present to the meeting a report of the work of the Institute for the year preceding, and a balance-sheet, duly audited, of all sums received and paid on behalf of the Institute.

9. The Board may from time to time, as it sees fit, make arrangements for the holding of general meetings of members of the Institute, at times and places to be arranged, for the reading of scientific papers, the delivery of lectures, and for the general promotion of science in New Zealand by any means that may appear desirable.

10. The Minister of Finance shall from time to time, without further appropriation than this Act, pay to the Board the sum of five hundred pounds in each financial year, to be applied in or towards payment of the general current expenses of the Institute.

11. Forthwith upon the making of any regulations or the publication of any Transactions, the Board shall transmit a copy thereof to the Minister of Internal Affairs, who shall lay the same before Parliament if sitting, or if not, then within twenty days after the commencement of the next ensuing session thereof.

SCHEDULE.

Enactments consolidated.

1903, No. 48.—The New Zealand Institute Act, 1903.

REGULATIONS.

THE following are the regulations of the New Zealand Institute under the Act of 1903:—*

The word "Institute" used in the following regulations means the New Zealand Institute as constituted by the New Zealand Institute Act, 1903.

INCORPORATION OF SOCIETIES.

1. No society shall be incorporated with the Institute under the provisions of the New Zealand Institute Act, 1903, unless such society shall consist of not less than twenty-five members, subscribing in the aggregate

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* *New Zealand Gazette*, 14th July, 1904.

a sum of not less than £25 sterling annually for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the President for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £25.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the New Zealand Institute.

4. Any society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue specified in Regulation No. 3 aforesaid in manner provided shall from henceforth cease to be incorporated with the Institute.

Publications.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and then may be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications :—

(*a.*) The publications of the Institute shall consist of—

(1.) A current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute";

(2.) And of transactions comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), and of such other matter as the Board of Governors shall from time to time determine to publish, to be intituled "Transactions of the New Zealand Institute."

(*b.*) The Board of Governors shall determine what papers are to be published.

(*c.*) Papers not recommended for publication may be returned to their authors if so desired.

(*d.*) All papers sent in for publication must be legibly written, typewritten, or printed.

(*e.*) A proportional contribution may be required from each society towards the cost of publishing Proceedings and Transactions of the Institute.

(*f.*) Each incorporated society will be entitled to receive a proportional number of copies of the Transactions and Proceedings of the New Zealand Institute, to be from time to time fixed by the Board of Governors.

Management of the Property of the Institute.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of

Governors for public advantage, in like manner with any other of the property of the Institute.

7. All donations by societies, public Departments, or private individuals to the Institute shall be acknowledged by a printed form of receipt and shall be entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

Honorary Members.

8. The Board of Governors shall have power to elect honorary members (being persons not residing in the Colony of New Zealand), provided that the total number of honorary members shall not exceed thirty.

9. In case of a vacancy in the list of honorary members, each incorporated society, after intimation from the Secretary of the Institute, may nominate for election as honorary member one person.

10. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the President of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

General Regulations.

11. Subject to the New Zealand Institute Act, 1908, and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by-laws for their own management, and shall conduct their own affairs.

12. Upon application signed by the President and countersigned by the Secretary of any society, accompanied by the certificate required under Regulation No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing regulations of the Institute are complied with by the society.

13. In voting on any subject the President is to have a deliberate as well as a casting vote.

14. The President may at any time call a meeting of the Board, and shall do so on the requisition in writing of four Governors.

15. Twenty-one days' notice of every meeting of the Board shall be given by posting the same to each Governor at an address furnished by him to the Secretary.

16. In case of a vacancy in the office of President, a meeting of the Board shall be called by the Secretary within twenty-one days to elect a new President.

17. The Governors for the time being resident or present in Wellington shall be a Standing Committee for the purpose of transacting urgent business and assisting the officers.

18. The Standing Committee may appoint persons to perform the duties of any other office which may become vacant. Any such appointment shall hold good until the next meeting of the Board, when the vacancy shall be filled.

19. The foregoing regulations may be altered or amended at any annual meeting, provided that notice be given in writing to the Secretary of the Institute not later than the 30th November.

THE HUTTON MEMORIAL MEDAL AND RESEARCH FUND.

RESOLVED by the Board of Governors of the New Zealand Institute that—

1. The funds placed in the hands of the Board by the committee of subscribers to the Hutton Memorial Fund be called "The Hutton Memorial Research Fund," in memory of the late Captain Frederick Wollaston Hutton, F.R.S. Such fund shall consist of the moneys subscribed and granted for the purpose of the Hutton Memorial, and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust-moneys.

3. A sum not exceeding £100 shall be expended in procuring a bronze medal to be known as "The Hutton Memorial Medal."

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as aforesaid as may be approved of by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund.

5. The Hutton Memorial Medal shall be awarded from time to time by the Board of Governors, in accordance with these regulations, to persons who have made some noticeable contribution in connection with the zoology, botany, or geology of New Zealand.

6. The Board shall make regulations setting out the manner in which the funds shall be administered. Such regulations shall conform to the terms of the trust.

7. The Board of Governors may, in the manner prescribed in the regulations, make grants from time to time from the accrued interest to persons or committees who require assistance in prosecuting researches in the zoology, botany, or geology of New Zealand.

8. There shall be published annually in the "Transactions of the New Zealand Institute" the regulations adopted by the Board as aforesaid, a list of the recipients of the Hutton Memorial Medal, a list of the persons to whom grants have been made during the previous year, and also, where possible, an abstract of researches made by them.

REGULATIONS UNDER WHICH THE HUTTON MEMORIAL MEDAL SHALL BE AWARDED AND THE RESEARCH FUND ADMINISTERED.

1. Unless in exceptional circumstances, the Hutton Memorial Medal shall be awarded not oftener than once in every three years; and in no case shall any medal be awarded unless, in the opinion of the Board, some contribution really deserving of the honour has been made.

2. The medal shall not be awarded for any research published previous to the 31st December, 1906.

3. The research for which the medal is awarded must have a distinct bearing on New Zealand zoology, botany, or geology.

4. The medal shall be awarded only to those who have received the greater part of their education in New Zealand or who have resided in New Zealand for not less than ten years.

5. Whenever possible, the medal shall be presented in some public manner.

6. The Board of Governors may, at an annual meeting, make grants from the accrued interest of the fund to any person, society, or committee for the encouragement of research in New Zealand zoology, botany, or geology.

7. Applications for such grants shall be made to the Board before the 30th September.

8. In making such grants the Board of Governors shall give preference to such persons as are defined in regulation 4.

9. The recipients of such grants shall report to the Board before the 31st December in the year following, showing in a general way how the grant has been expended and what progress has been made with the research.

10. The results of researches aided by grants from the fund shall, where possible, be published in New Zealand.

11. The Board of Governors may from time to time amend or alter the regulations, such amendments or alterations being in all cases in conformity with resolutions 1 to 4.

Award of the Hutton Memorial Medal.

1911. Professor W. B. Benham, D.Sc., F.R.S., University of Otago—For researches in New Zealand zoology.

1914. Dr. L. Cockayne, F.R.S., F.L.S.—For researches on the ecology of New Zealand plants.

Grants from the Hutton Memorial Research Fund.

1914. (1.) To F. W. Hilgendorf, D.Sc.—£10 for apparatus required in the investigation of the artesian wells of Christchurch and neighbourhood.

(2.) To Mr. T. Hall—£20 for expenses in collecting specimens of New Zealand fauna for Major T. Broun and Professor C. Chilton.

HECTOR MEMORIAL RESEARCH FUND.

Declaration of Trust.

This deed, made the twenty-seventh day of January, one thousand nine hundred and twelve, between the New Zealand Institute, a body corporate duly incorporated by the New Zealand Institute Act, 1908, of the one part, and the Public Trustee, of the other part: Whereas the New Zealand Institute is possessed of a fund consisting now of the sum of one thousand and forty-five pounds ten shillings and twopence (£1,045 10s. 2d.), held for the purpose of the Hector Memorial Research Fund on the terms of the rules and regulations made by the Governors of the said Institute hereinafter set forth: And whereas the said money has been transferred to the Public Trustee for the purposes of investment, and the Public Trustee now holds the same for such purposes, and it is expedient to declare the trusts upon which the same is held by the Public Trustee:

Now this deed witnesseth that the Public Trustee shall hold the said moneys, and all other moneys which shall be handed to him by the said Governors, for the same purposes upon trust from time to time, to invest the same in the common fund of the Public Trust Office, and to hold the principal and income thereof for the purposes set out in the said rules hereinafter set forth.

And it is hereby declared that it shall be lawful for the Public Trustee to pay, and he shall pay, all or any of the said moneys, both principal and interest, to the Treasurer of the said New Zealand Institute upon being directed so to do by a resolution of the Governors of the said Institute, and a letter signed by the Secretary of the said Institute, enclosing a copy of such resolution, certified by him and by the President as correct, shall be sufficient evidence to the Public Trustee of the due passing of such resolution: And upon receipt of such letter and copy, the receipt of the Treasurer for the time being of the said Institute shall be a sufficient discharge to the Public Trustee: And in no case shall the Public Trustee be concerned to inquire into the administration of the said moneys by the Governors of the said Institute.

As witness the seals of the said parties hereto, the day and year first hereinbefore written.

Rules and Regulations made by the Governors of the New Zealand Institute in relation to the Hector Memorial Research Fund.

1. The funds placed in the hands of the Board by the Wellington Hector Memorial Committee be called "The Hector Memorial Research Fund," in memory of the late Sir James Hector, K.C.M.G., F.R.S. Such fund shall consist of the moneys subscribed and granted for the purpose of the memorial, and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust-moneys.

3. A sum not exceeding one hundred pounds (£100) shall be expended in procuring a bronze medal, to be known as the Hector Memorial Medal.

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as may be approved by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund.

5. The Hector Memorial Medal and Prize shall be awarded annually by the Board of Governors.

6. The research for which the medal and prize are awarded must have a distinct bearing on New Zealand—(1) Botany, (2) chemistry, (3) ethnology, (4) geology, (5) physics (including mathematics and astronomy), (6) zoology (including animal physiology).

7. Whenever possible the medal shall be presented in some public manner.

AWARD OF THE HECTOR MEMORIAL RESEARCH FUND.

1912. L. Cockayne, Ph.D., F.L.S., F.R.S. — For researches in New Zealand botany.

1913. T. H. Easterfie'd, M.A., Ph.D.—For researches in chemistry.

1914. Elsdon Best—For researches in New Zealand ethnology.

NEW ZEALAND INSTITUTE:

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED THE NEW ZEALAND INSTITUTE ACT, 1867; RECONSTITUTED BY AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND UNDER THE NEW ZEALAND INSTITUTE ACT, 1903, AND CONTINUED BY THE NEW ZEALAND INSTITUTE ACT, 1908.

Board of Governors.

EX OFFICIO.

His Excellency the Governor.
The Hon. the Minister of Internal Affairs.

NOMINATED BY THE GOVERNMENT.

Charles A. Ewen (December, 1912); A. H. Turnbull (December, 1912); Dr. J. Allan Thomson (December, 1914); Professor G. W. von Zedlitz, M.A. (December, 1914).

ELECTED BY AFFILIATED SOCIETIES (DECEMBER, 1913).

Wellington Philosophical Society ...	Professor T. H. Easterfield, M.A., Ph.D. Professor H. B. Kirk, M.A.
Auckland Institute	D. Petrie, M.A., Ph.D. J. Stewart, C.E.
Philosophical Institute of Canterbury ...	C. Coleridge Farr, D.Sc. R. Speight, M.A., M.Sc., F.G.S.
Otago Institute	Professor Marshall, D.Sc., F.G.S. G. M. Thomson, M.P., F.C.S.
Hawke's Bay Philosophical Institute ...	H. Hill, B.A., F.G.S.
Nelson Institute	L. Cockayne, Ph.D., F.L.S., F.R.S.
Manawatu Philosophical Society ...	K. Wilson, M.A.
Wanganui Philosophical Society ..	Dr. H. R. Hatherly, M.R.C.S.

OFFICERS FOR THE YEAR 1914.

President: C. Chilton, D.Sc., M.A., M.B., LL.D., F.L.S.

Hon. Treasurer: C. A. Ewen.

Hon. Editor: C. Chilton, D.Sc., M.A., M.B., LL.D., F.L.S.

Secretary: B. C. Aston, F.I.C., F.C.S.
(Box 40, Post-office, Wellington.)

AFFILIATED SOCIETIES.	DATE OF AFFILIATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury ...	22nd October, 1868.
Otago Institute	18th October, 1869.
Hawke's Bay Philosophical Institute ...	31st March, 1875.
Nelson Institute	20th December, 1883.
Manawatu Philosophical Society	6th January, 1905.
Wanganui Philosophical Society	2nd December, 1911.

FORMER HONORARY MEMBERS.

1870.

Agassiz, Professor Louis.
Drury, Captain Byron, R.N.
Flower, Professor W. H., F.R.S.
Hochstetter, Dr. Ferdinand von.
Hooker, Sir J. D., G.C.S.I., C.B., M.D., F.R.S., O.M.
Mueller, Ferdinand von, M.D., F.R.S., C.M.G.
Owen, Professor Richard. F R.S.
Richards, Rear-Admiral G. H.

1871.

Darwin, Charles, M.A., F.R.S.
Gray, J. E., Ph.D., F.R.S.
Lindsay, W. Lauder, M.D., F.R.S.E.

1872.

Grey, Sir George, K.C.B.
Huxley, Thomas H., LL.D., F.R.S.
Stokes, Vice-Admiral J. L.

1873.

Bowen, Sir George Ferguson, G.C.M.G.
Lyell, Sir Charles, Bart., D.C.L., F.R.S.

1874.

McLachlan, Robert, F.L.S.
Newton, Alfred, F.R.S.
Thomson, Professor Wyville, F.R.S.

1875.

Filhol, Dr. H.
Rolleston, Professor G., M.D., F.R.S.
Sclater, P. L., M.A., Ph.D., F R.S.

1876.

Clarke, Rev. W. B., M.A., F.R.S.
Etheridge, Professor R., F.R.S.

1877.

Baird, Professor Spencer F.
Weld, Frederick A., C.M.G.

1878.

Garrod, Professor A. H., F.R.S.
Müller, Professor Max, F.R.S.
Tenison-Woods, Rev. J. E., F.L.S.

1880.

The Most Noble the Marquis of Normanby, G.C.M.G.

1883.

Carpenter, Dr. W. B., C.B., F.R.S.
Ellery, Robert L. J., F.R.S.
Thomson, Sir William, F.R.S.

1885.

Gray, Professor Asa.
Sharp, Richard Bowdler, M.A., F.R.S.
Wallace, A. R., F.R.S., O.M.

1888.

Beneden, Professor J. P. van.
Ettingshausen, Baron von.
McCoy, Professor F., D.Sc., C.M.G. F.R.S.

1890.

Riley, Professor C. V.

1891.

Davis, J. W., F.G.S., F.L.S.

1895.
Mitten, William, F.R.S.

1896.
Langley, S. P.

1900.
Agardh, Dr. J. G. | Avebury, Lord, P.C., F.R.S.

1901.
Eve, H. W., M.A. | Howes, G. B., LL.D., F.R.S.

1906.
Milne, J., F.R.S.

1909.
Darwin, Sir George, F.R.S.

FORMER MANAGER AND EDITOR.

[Under the New Zealand Institute Act, 1867.]

1867–1903.
Hector, Sir James, M.D., K.C.M.G., F.R.S.

PAST PRESIDENTS.

1903–4.
Hutton, Captain Frederick Wollaston, F.R.S.

1905–6.
Hector, Sir James, M.D., K.C.M.G., F.R.S.

1907–8.
Thomson, George Malcolm, F.L.S., F.C.S., M.P.

1909–10.
Hamilton, A.

1911–12.
Cheeseman, T. F., F.L.S., F.Z.S.

HONORARY MEMBERS.

1870.
Finsch, Professor Otto, Ph.D., Braunschweig, Germany.

1873.
Günther, A., M.D., M.A., Ph.D., F.R.S., Litchfield Road, Kew Gardens, Surrey. | Pickard-Cambridge, The Rev. O., M.A., C.M.Z.S.

1876.

BERGGREN, Dr. S., Lund, Sweden.

1877.

SHARP, Dr. D., University Museum, Cambridge.

1890.

LIVERSIDGE, Professor A., M.A., F.R.S., Fieldhead, Coombe Warren, Kingston Hill, England.

NORDSTEDT, Professor OTTO, Ph.D., University of Lund, Sweden.

1891.

GOODALE, Professor G. L., M.D., LL.D., Harvard University, Massachusetts, U.S.A

1894.

CODRINGTON, Rev. R. H., D.D., Wadhurst Rectory, Sussex, England.

THISELTON-DYER, Sir W. T., K.C.M.G., C.I.E., LL.D., M.A., F.R.S., Royal Gardens, Kew.

1896.

LYDEKKER, RICHARD, B.A., F.R.S., British Museum, South Kensington.

1900.

MASSEE, GEORGE, F.L.S., F.R.M.S., Royal Botanic Gardens, Kew.

1901.

VON GOEBEL, Professor Dr. CARL, University of Munich.

1902.

SARS, Professor G. O., University of Christiania, Norway.

1903.

KLOTZ, Professor OTTO J., 437 Albert Street, Ottawa, Canada.

1904.

RUTHERFORD, Professor Sir E., D.Sc., F.R.S., University of Manchester.

DAVID, Professor T. EDGEWORTH, F.R.S., C.M.G., Sydney University, N.S.W.

1906.

BEDDARD, F. E., F.R.S., Zoological Society, London.

BRADY, G. S., F.R.S., University of Durham, England.

1907.

DENDY, Dr., F.R.S., King's College, University of London, England.

DIELS, Professor L., Ph.D., University of Marburg.

MEYRICK, E., B.A., F.R.S., Marlborough College, England.

STEBBING, Rev. T. R. R., F.R.S., Tunbridge Wells, England.

1910.

BRUCE, Dr. W. S., Edinburgh.

1913.

DAVIS, Professor W. MORRIS, Harvard University.

HEMSLEY, W. BOTTING, England.

1914.

ARBER, Dr. E. NEWELL, Cambridge, Eng.

BALFOUR, Professor J. BAYLEY, F.R.S., Royal Botanic Gardens, Edinburgh.

HASWELL, Professor W. A., F.R.S, University, Sydney.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life members. † Honorary members.]

Acland, E. W., Box 928, Wellington
Adams, C. E., M.Sc., A.I.A. (London), F.R.A.S., Hector Observatory, Wellington
Adams, C. W., Bellevue Road, Lower Hutt
Adamson, Professor J., Victoria College, Wellington
Adkin, G. L., Queen Street, Levin
Alabaster, A. H., care of District Engineer, Railways, Auckland
Anderson, W. J., M.A., LL.D., Education Department, Wellington
Aston, B. C., F.I.E., F.C.S., Dominion Laboratory, Wellington
Atkins, A., F.R.I.B.A., Assoc.M. Inst.C.E., Box 187, Wellington
Atkinson, E. H., Agricultural Department
Bagley, G., Young's Chemical Company, Wellington
Bakewell, F. H., M.A., Education Board, Wellington
Baldwin, C. S., 215 Lambton Quay, Wellington
Bartrum, J. A., M.Sc., University College, Auckland
Beere, W. O., 155 Featherston Street, Wellington
Beetham, W. H., Masterton
Begg, Dr. C. M., 164, Willis Street, Wellington
Bell, E. D., Panama Street, Wellington
Bell, Hon. H. D., K.C., Panama Street, Wellington
Berry, C. G. G., 35 Bolton Street, Wellington
Blair, David K., M.I.Mech.E., Box 941, Wellington
Blair, J. R., 241 The Terrace, Wellington
Blake, V. Survey Office, Wellington
Blow, H. J. H., Public Works Department, Wellington
Brandon, A. de B., B.A., Featherston Street, Wellington
Bridges, G. G., 2 Wesley Road, Wellington
Browne, M. H., Education Department
Burnett, J., M.Inst.C.E., Railway Department
Campbell, J., F.R.I.B.A., Public Works Department, Wellington
Campbell, O. N., Rangitaiki Drainage-works, Matata
Carter, F. J., M.A., Diocesan Office, Wellington
Carter, W. H., care of Dr. Henry, The Terrace, Wellington
Chapman, Martin, K.C., Brandon Street, Wellington
Christie, Mrs. H. M., 158 Moxham Avenue, Kilbirnie
Chudleigh, E. R., Orongomairoa, Waihou
Climie, J. D., Lower Hutt
Cotton, C. A., M.Sc., Victoria College, Wellington
Crawford, A. D., Box 126, Wellington
Crewes, Rev. J., 90 Owen Street, Wellington
Darken, E. M., Box 266, Wellington
Dougall, A., 34 Austin Street, Wellington
Dymock, E. R., A.I.A.N.Z., Woodward Street, Wellington
Easterfield, Professor T. H., M.A., Ph.D., 18 Talavera Terrace, Wellington
Ewen, C. A., 126 The Terrace, Wellington
Ferguson, William, M.A., M.Inst. C.E., M.Inst.Mech.E., 131 Coromandel Street, Wellington
Field, W. H., 160 Featherston Street, Wellington
FitzGerald, Gerald, A.M.Inst.C.E., Government Insurance Building, Wellington

Fleming, T. R., M.A., LL.B., Education Board, Wellington
Fletcher, Rev. H. J., The Manse, Taupo
Fox, T. O., Borough Council, Mirimar
Fraser, G. V. R., Railway Department
Freeman, H. J., Manners Street, Wellington
Freyberg, C., Tourist Department, Wellington
Fulton, J., 14 North Terrace, Kelburne
Furkert, F. W., Assoc.M.Inst.C.E., Public Works Department, Wellington
Garrow, Professor J. M. E., B.A., LL.B., Victoria College, Wellington
Gibbs, A., Telegraph Department
Gifford, A. C., M.A., 6 Shannon Street, Wellington*
Girdlestone, H. E., Lands and Survey Department
Goudie, H. A., Whakarewarewa
Graham, K. M., A.O.S.M., Defence Department
Hanify, H. P., 18 Panama Street, Wellington
Harding, R. Coupland, 63 Matai Road, Kilbirnie
Hastie, Miss J. A., care of Street and Co., 30 Cornhill, London, E.C.*
Hayward, Captain J. A., 113 Tasman Street, Wellington
Heard, Colonel E. S., 5 Oriental Terrace, Wellington
Hector, Barclay, Lower Hutt
Hector, C. Monro., M.D., B.Sc., Lower Hutt
Helyer, Miss E., 13 Tonks Grove, Wellington
Henderson, J., M.A., D.Sc., B.Sc. in Engineering (Metall.)
Herdman, Hon. A. L., Attorney-General, Wellington
Hislop, J., Department of Internal Affairs, Wellington
Hodson, W. H., 40 Pirie Street, Wellington
Hogben, G., M.A., F.G.S., Education Department, Wellington
Holmes, J. D., Public Works Department, Wellington
Holmes, R. L., F.R.Met.S., Kaiora, Fern Street, Randwick, Sydney*
Holmes, R. W., M.Inst.C.E., Public Works Department, Wellington
Hooper, Captain G. S., Grant Road North, Wellington
Howlett, W. F., B.A. (Oxon), Tane, Eketahuna
Hudson, G. V., F.E.S., Inspector's Office, G.P.O., Wellington
Hursthouse, E. W., Routh's Buildings, Wellington
Isaac, E. C., Education Department, Wellington
Jenkinson, S. H., Railway Department, Wellington
Johnston, C. G., Railway Department, Wellington
Johnston, Hon. G. Randall, care of Martin Chapman, Brandon Street, Wellington*
Joseph, Joseph, Box 443, Wellington
Kennedy, Rev. D., D.D., F.R.A.S., St. Patrick's College, Wellington
Kihoe, Miss F., 7 Hay Street, Wellington
King, G. W., B.E. (Civil), Public Works Department, Wellington
King, Thomas, F.R.A.S., 58 Ellice Street, Wellington*
Kirk, Professor H. B., M.A., Victoria College, Wellington
Krull, F. A., care of F. R. Jackson and Co., Wanganui
Laby, Professor T. H., B.A., Victoria College, Wellington
La Trobe, W. S., M.A., Technical College, Wellington
Levi, P., M.A., 15 Stout Street, Wellington
Lomas, E. K., M.A., M.Sc., Training College, Wellington
Lomax, Major H. A., Araruhe, Aramoho, Wanganui
Luke, John P., Hiropi Street, Wellington
Luke, K. E., care of City Engineer, Wellington
McCabe, U., Grey Street, Wellington
Mackay, J., Government Printing and Stationery Department, Wellington

McKenzie, Donald, Carnarvon, Feilding
Mackenzie, Professor H., M.A., Victoria College, Wellington
Mackenzie, J., Lands and Survey Department, Wellington
Maclaurin, J. S., D.Sc., F.C.S., Dominion Laboratory, Wellington
MacLean, F. W., M.Inst.C.E., Railway Department, Wellington
Marchbanks, J., M.Inst.C.E., Harbour Board, Wellington
Mason, J. Malcolm, M.D., F.C.S., D.P.H. (Camb.), Barrister-at-Law, Lower Hutt
Mason, Mrs. K., care of Miss Campbell, Sumner
Maxwell, J. P., M.Inst.C.E., 145 Dixon Street, Wellington
Mestayer, R. L., M.Inst.C.E., 139 Sydney Street, Wellington
Miles, P. H. R., Telegraph Department, Wellington
Moore, G., Eparaima, Masterton
Moore, W. L., Bank Chambers, Lambton Quay, Wellington
Moorhouse, W. H. Sefton, 134 Dixon Street, Wellington
Morgan, P. G., M.A., Geological Survey Branch, Wellington
Morice, J. M., B.Sc., care of City Engineer, Wellington
Morison, C. B., K.C., 180 Featherston Street, Wellington
Morris, W. R., Post and Telegraph Department, Wellington
Morrison, J. C., Box 8, P.O., Eltham
Morton, W. H., M.Inst.C.E., Town Hall, Wellington
Myers, Miss P., B.A., 26 Fitzherbert Terrace, Wellington
Newman, A. K., M.B., M.R.C.P., M.P., 56 Hobson Street, Wellington
Nicol, John, 57 Cuba Street, Wellington
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